ENCLAVE AT EAGLE CLIFF FINAL DRAINAGE PLAN

The Vanderburgh County Drainage Board at its regularly scheduled meeting of October 28, 2014 does hereby approve the ENCLAVE AT EAGLE CLIFF FINAL DRAINAGE PLAN (hereafter referred to as the APPROVED PLAN). The APPROVED PLAN consists of the FINAL DRAINAGE PLAN SUBMITTAL, ADDITIONAL CONDITIONS OF APPROVAL OF FINAL DRAINAGE PLAN and the ADDITIONAL STIPULATIONS OF THE FINAL DRAINAGE PLAN, the contents and/or requirements of which are summarized in detail and made part of the APPOVED PLAN.

FINAL DRAINAGE PLAN SUBMITTAL

The FINAL DRAINAGE PLAN SUBMITTAL consists of the following:

- Final Drainage Report Revised for Enclave at Eagle Cliff, Vanderburgh County, Indiana Project No.: 8699.6.001 A October 7, 2014 prepared by Morley and Associates
- Response Letter dated October 7, 2014 to Jeff Mueller, Vanderburgh County Surveyor (3 pages plus 2 pages of inserts)
- Drawing C102 Grading and Drainage Plan as submitted on 10/24/2014
- Drawing C108 Storm Sewer and Drainage Details as submitted with the 10/7/2014 submittal
- Basin Drawing Basn1 Section A2 Alignment Profile as submitted electronically 10/13/2014
- Basin Drawing Basn 2 Section B2 Alignment Profile as submitted electronically 10/13/2014
- Basin Drawing Bsn2 Section B3 Alignment Profile as submitted electronically 10/13/2014
- Drawing C104 Storm Water Pollution Prevention Plan as submitted 10/24/2014
- Drawing C114 Erosion and Sediment Control Details as submitted electronically 10/14/2014
- Drawing C115 Erosion and Sediment Control Details as submitted electronically 10/14/2014
- Revised second page of write up to correct typo as submitted electronically on 10/13/2014
- Form 800 Basin 1 as submitted electronically on 10/14/2014
- Form 800 Basin 2 as submitted electronically on 10/14/2014
- Letter dated 10/24/2014 with revised swale design for Swale 200

Enclosed as an attachment for reference only and NOT to be included as part of the APPOVED PLAN is a series of emails between Bethany Hopf of Morley and Associates and Jeff Mueller and John Stoll.

ADDITIONAL CONDITIONS OF APPROVAL OF FINAL DRAINAGE PLAN

In addition to the FINAL DRAINAGE PLAN SUBMITTAL the following conditions shall be included in the APPROVED PLAN:

- The developer shall order by November 7, 2014 the specified gabion blankets and shall provide to the County Surveyor sufficient proof that the required gabion blankets were ordered.
- The Developer shall complete the construction of Basin #1 and Basin #2 per the submitted Final Drainage Plan in their entirety by November 30, 2014.
- The Developer shall immediately seed the entire subdivision, install required erosion control blanket, and achieve a 90% cover with appropriate vegetation. BY NOVEMBER 30, 2014. The exception to this shall be any lot within Section 1 of the platted Enclave Subdivision with an active home under construction (issued building permit from Evansville Vanderburgh County Building Commission) in which case the said lot shall meet the erosion control requirements for that lot.
- The Developer shall immediately repair or replace all failed erosion control measures on the site, and he shall provide maintenance on all erosion control measures requiring maintenance. The Developer shall also immediately install all necessary erosion control measures that are needed to adequately prevent polluted storm water from leaving the site as stated in Vanderburgh County Code 13.05.11.C.8 By 11/30/2014
- Any reseeding for permanent vegetation shall be installed with erosion control blankets and shall be maintained in order to achieve 90% coverage.
- **As a further condition of the approval, the development of any further sections of the subdivision, including platting additional sections of the subdivision, will not be permitted until such time as all of the above requirements are met in their entirety. Any county imposed restriction of development shall not preclude the developer from completing the installation and maintenance of all erosion control measures, nor will it restrict or prevent the Developer from completing all required drainage facilities on the site. Erosion control work and drainage work will still be required even if no further sections of the subdivision or platted.**

WITH THE EXCEPTION OF ROCKING AND PAVING OF 500' OF STELLAR DRIVE

ADDITIONAL STIPULATIONS OF THE FINAL DRAINAGE PLAN

The following additional stipulations shall also be included within the APPROVED PLAN.

- Vanderburgh County through its technical advisors as defined in the Vanderburgh County Drainage Code Section 13.04.025B utilizing statistically measurable methods, photography or other scientific methods shall be the sole final judges in determining whether the requirements of coverage have been satisfied.
- Per Section 13.04.045 of the Vanderburgh County Drainage Code, the approval of this Final Drainage Plan by the Vanderburgh County Drainage Board will not relieve the applicant of compliance with other applicable ordinances or compliance with applicable state and federal laws and regulations.
- In the event that stabilization of the entire Enclave site is not stabilized by Nov. 30, 2014, the County Commissioners reserve the right to issue a stop work order for section 1 of Enclave. This would be in accordance with section 13.05.16.B.4 of the Vanderburgh County Code. The only exclusion to the stop work order would be the installation, repair, and/or replacement of necessary erosion control measures within the site.

VANDERBURGH COUNTY
BOARD OF COMMISSIONERS

Joe Kiefer, President

Marsha Abell, Vice President

Stephen R. Melcher, Member

10/28/14

Mueller, Jeffrey

From: Bethany Hopf <bethanyh@morleyandassociates.com>
Sent: Tuesday, October 14, 2014 1:40 PM
To: Stoll, John
Cc: Mueller, Jeffrey; James E. Morley; Dan
Subject: RE: Enclave Comments
Attachments: Basin 1 stage storage.pdf; Basin 2 stage storage.pdf; C104.pdf; C114.pdf; C115.pdf

John and Jeff,
I've reduced the email to the questions you last posed in order to keep things simpler.

- **Basin Construction Timing:**
  - What happens if weather does not permit? The developer will immediately install temporary seeding appropriate for the season with erosion control blankets which shall be maintained until work is able to begin as weather permits. Then once the work is completed, permanent seeding shall be installed with erosion control blankets which shall be maintained until a stable stand of grass is achieved (90% coverage). Reseeding and additional erosion control blankets shall be maintained/re-installed until 90% coverage is achieved.
  - If the plan is approved how soon will Gabion Blankets be ordered? Per the developer, gabion mattresses will be ordered next week.
- **SWPPP Sheets:** Sheet C114 was not previously submitted with the Drainage Plan. Typically the SWPPP sheets are not submitted as part of the drainage plans for approval as these sheets are approved separately by the county engineer and the drainage plans are approved separately by the county surveyor. Due to the unique nature of this project and the requsted information regarding SWPPP on the site for the drainage basin revision approval, they were provided for reference. The full SWPPP report can be found at the county engineers office. I have also attached C115 as reference so that you have all of the SWPPP details for the project in case any additional questions arise.
- **Stage Storage Information:**
  - Cannot find these. I have attached stage storage information.
- **Permitting Timeline:**
  - What is the status of IDEM and USCOE approvals? Per the developer, the permits should be issued by the end of the month.
  - Based on the August 26, 2014 email from Rob Brown of the Corps of Engineers to Manuel Ball of Jagoe Homes shown below, it was our understanding that the stop work order had been lifted and there were no restrictions on working on this site. Is this incorrect, and are there still restrictions on this site? If so, what areas are still restricted? IDEM approved work to continue in upland areas of the site prior to approval of the permits since a workable mitigation plan is in place, just not yet approved. All of the lots in Section 1 are within the upland areas. The basins, however, are within the lowland areas where work is restricted.
- **Future Sub Development/Basin Construction Timing:**
  - What happens if weather does not permit? See comments above.
  - Does developer plan to move forward with additional sections should the basin not be completed? The developer intends to move forward with the basin work as quickly as possible. He would like to record the next section connecting to the apartments as soon as possible also.
  - The recommendation to the Drainage Board will be that no additional sections be platted until such time as the basin construction is complete and basin is stabilized with vegetation (90% cover). Noted.
- **Plan Sheet Certification:**
  - Sheets 104 and 114 require Certification. IDEM Rule 5 does not require that SWPPP plans and details be certified, so we generally do not. Sheets C104 and C114 are SWPPP and were only included in the drainage submittal as reference to erosion control design because questions and comments were made

regarding specific SWPPP related items. However, as requested, certified sheets C104, C114 (and C115) are attached.

Thank you.

Bethany S. Hopf, P.E.

Morley and Associates, Inc.
4800 Rosebud Lane
Newburgh, IN 47630
Phone: (812) 464-9585

From: Stoll, John [mailto:JStoll@vanderburghgov.org]
Sent: Monday, October 13, 2014 4:49 PM
To: Bethany Hopf
Cc: Mueller, Jeffrey
Subject: FW: Enclave Comments

Bethany,
Here are the updated questions and comments that Jeff and I have regarding the revised drainage plan. Let me or Jeff know if you have any questions.

Thanks.
John

From: Mueller, Jeffrey
Sent: Monday, October 13, 2014 3:16 PM
To: Stoll, John
Subject: FW: Enclave Comments

John,

See my comments below. I have not sent these out; feel free to add.

Jeff

From: Bethany Hopf [mailto:bethanyh@morleyandassociates.com]
Sent: Monday, October 13, 2014 8:59 AM
To: Stoll, John
Cc: Mueller, Jeffrey; James E. Morley; Dan
Subject: RE: Enclave Comments

John and Jeff,
Thank you for the quick review and response. I have provided comments below in Red along with attachments providing the requested information.

Thank you.

Bethany S. Hopf, P.E.

Morley and Associates, Inc.

4800 Rosebud Lane
Newburgh, IN 47630
Phone: (812) 464-9585

From: Stoll, John [mailto:JStoll@vanderburghgov.org]
Sent: Thursday, October 09, 2014 3:15 PM
To: Bethany Hopf
Cc: Mueller, Jeffrey
Subject: FW: Enclave Comments

Bethany,
Here are the comments that Jeff and I have regarding the revised drainage plan for Enclave. Let me or Jeff know if you have any questions.

Thanks.
John

Per the submitted letter

- #2-Basin Construction timing-see note below regarding unvegetated areas-if the basins have been inactive for 15 days, then this work needs to proceed and not wait for approval of Drainage Plan. Dan, please provide erosion control as noted below as soon as possible for all unvegetated areas on the site for all areas that will remain inactive for a period of 15 days or more.

- #4-no pictures were provided. I have attached pictures as a PDF.

- #6a-Gabion Mattresses to be installed but not specified on drawing. Also how much area will the mattresses cover-a detailed drawing needs to be supplied showing the area that these will cover. I have added details for the gabion mattresses on the plan sheet C104. A PDF of the plan is attached. Provided.

- #8 When will basin #2 construction occur? This construction timing should be stated in relation to the development of future lots. Basin 2 construction will occur as soon as the IDEM and Corps approvals are obtainted and work is allowed in the basin area. Section 1 of the subdivision will be recorded as soon as possible. Per the developer, the basin work will be completed by November 30, weather permitting. What happens if weather does not permit? If the plan is approved how soon will Gabion Blankets be ordered?

- #9 Will the emergency overflow rip rap be installed with fabric? Please see the new notes on sheet C104 and the details referenced on sheet C104 and C114. Sheet C114 was not previously submitted with the Drainage Plan.

On the submittal itself the following comments

- The submittal requests that "constructed basin #1 to be approved as a revision"-it is unclear from the drawings (as there is only one cross section) if the constructed basin has 4:1 side slopes as required for a grass lined basin. I have created additional cross sections of the as-built basins for your review. Provided. Code requires 10' of maintenance around basin-will all of this fit within the Drainage Easements; need drawings to show that this will meet the code prior to any approval of "as constructed basin" being approved A waiver was requested as part of the original design to relax the required 10' maintenance around the basin along with allowing structures within 50' of the basin. The waiver was approved with the original design approval. Noted.

- There is no stage storage diagram for basin 1. It is unclear from the calculation page regarding basin 2 if the required storage will be met prior to the discharge through the emergency spillway. For basin 2, on the provided stage storage diagram please utilized actual elevations instead of 0,1,2, 3, 3.88 and 4. I have attached stage storage information for both basins with elevation and depth noted on each. Cannot find these.

- The Drainage Code states that all work will be completed prior to construction of building. The code allows for phase in building of larger subdivisions. If this is the case, the Developer needs to commit to a time table of when basins when be completed in reference to the overall development. Basin work will begin as soon as possible after receiving approvals from IDEM and the Corps to allow work in those areas again. What is the status of IDEM and USCOE approvals? Based on the August 26, 2014 email from Rob Brown of the Corps of Engineers to Manuel Ball of Jagoe Homes shown below, it was our understanding that the stop work order had been lifted and there were no restrictions on working on this site. Is this incorrect, and are there still restrictions on this site? If so, what areas are still restricted?

  From: "Brown, Robert J LRL" <Robert.J.Brown@usace.army.mil>
  Date: August 26, 2014 at 1:27:54 PM CDT
  To: Manuel Ball <manuel.ball@jagoehomes.com>
  Subject: RE: [EXTERNAL] The Enclave

  Manuel,

  Yes, that is correct. Although the subdivision does not have a 401 currently, the SHPO 106 of Historic Properties and consultation with USFWS is complete. Therefore, the Corps approved construction in upland areas. The enclave has already buried the Waters on site so the location of uplands vs. non is no longer an issue. I believe the proposed mitigation would replace lost functions of the buried waters. Therefore, the Corps Chief of Regulatory in Louisville was able to grant this request to work without issuance of the 401. This took some convincing and it wouldn't have happened if the other ducks were not in a row.

  Congratulations,

  Rob

  Section 1 of the subdivision will be recorded as soon as possible. Per the developer, the basin work will be completed by November 30, weather permitting. What happens if weather does not permit? Does developer plan to move forward with additional sections should the basin not be completed? The recommendation to the Drainage Board will be that no additional sections be platted until such time as the basin construction is complete and basin is stabilized with vegetation (90% cover).

- Page 2 of the narrative in the revised drainage report refers to pipe 100. Should this be P101? There is no P100 shown on the plans. Yes, it should have been P101. I've attached an updated narrative page 2 as a PDF.

- Modify sheet C104 to show staked sod on swales 201, 201, 202, 204, 207B, and 208 as required by the following ordinance: I have added staked sod to the plan sheet as requested, however, I would like to point out, and as evidenced by the attached photos as well, Swale 202 already has stable grass cover and does not currently require staked sod. There are portions of Swale 201 that require seeding of the flow line and staked sod shall be installed there, but the remaining length does not require sod because it is already vegetated. In the event that swales 201 and 202 are disturbed in the future, the plans will represent the need for staked sod.
  - **13.04.360 Erosion control by percentage of grade.**
    - The bottoms of seeded, grass-lined channels with grades from one percent to two percent shall have erosion control blankets properly installed.
    - Channels with grades greater than two percent and up to six percent shall have bottoms lined in staked sod.

- All channels with grades greater than six percent shall have bottoms lined with six-inch riprap.
- Side banks of grass-lined channels with a grade of two percent or greater shall be protected by erosion control blankets installed coincidental with seeding, and in accordance with manufacturer's recommendations.

- Add a note on sheet C104 to state the following: "Unvegetated areas that are scheduled or likely to be left inactive for fifteen (15) days or more must be temporarily or permanently stabilized with measures appropriate for the season to minimize erosion potential." This temporary stabilization is required by county ordinance number 13.05.11.C.16. Note has been added as requested. See the attached revised sheet C104.

Although this comment is not specific to the drainage plan revisions, this is a reminder that updated as built plans will be required for section 1 once all work has been completed. Additional work is required in both basins and in numerous swales (both in and out of section 1), so a final set of as built plans will be needed in order to show the final conditions of all drainage facilities. Final record drawings will be provided once the storm system in completed.

Sheets 104 and 114 require Certification.

John Stoll, P.E.
Vanderburgh County Engineer
201 NW Fourth St. Room 306
Evansville, IN 47708
Phone 812-435-5773
Fax 812-435-5676

ASSOCIATES:
James Q. Morley, P.E., P.L.S.
Lee A. McClellan, P.E.
Danny K. Leek, P.L.S.

Engineering ~ Surveying ~ Architecture ~ Construction Management

APPROVED
OCT 2 8 2014
VANDERBURGH COUNTY
DRAINAGE BOARD

October 24, 2014

Vanderburgh County Surveyor
Attention: Jeff Mueller
submitted by email only: JMueller@vanderburghsurveyor.com

Re: Enclave at Eagle Cliff
Swale 200 Revisions - For Approval
Morley and Associates, Inc. Project No. 8699.4.001 A

Dear Mr. Mueller,

This letter is in reference to the Enclave at Eagle Cliff revised drainage plan (C102) and SWPPP (C104) that I dropped off at your office this morning. The changes on these plans involve Swale 200 that runs along the back yard of lots 53-56 abutting the commercial lots and drains into Basin #1 along Felstead Road. The original drainage plan showed an average slope in S200 of 7.19%. Due to existing grades on the site, the developer would like to avoid excessive cuts to create the swale on the straight grade between the upstream elevation and the downstream elevation. In order to do this, we are proposing a grade break 50' from the downstream end of the swale creating two separate swales S200A and S200B with different slopes.

S200A will drain the rear yards of lots 54-56 and will have a 0.8% slope along the flow line. This will provide for minimal cuts in the rear yards and will also allow for flatter back yards which will be easier to stabilize with permanent vegetative cover.

S200B will drain S200A and the rear yard of lot 53 into Basin #1. S200B will mimic existing grading for the basin slopes, but will be a channel cut into the slope of the basin, with a slope of 20.28% along the flow line. The swale will be a channel cut into the bank of the basin to limit the extents of the flow path and to allow stabilization with rip rap along the channel flow line and up the side slopes. If there was no channel and rip rap was placed down the slope, the water from the S200A would likely plume out and flow in a wider path outside of the riprap and cause erosion. The rip rap proposed will extend up the flow line of S200A for a distance of 2' and shall be keyed in at the upstream end to a depth of 1' in order to provide a more stable transition between the slopes. Because the flow anticipated for this swale is low, even with the steep slope of

the flow line, the flow velocity at the designed flow rate is only 6.88 fps. See the attached flow velocity calculations.

A drop structure is not proposed because there would be continual maintenance of the drain opening to prevent clogging. If water were to overtop the drain, it would still run down the steep bank to the basin without the benefit of rip rap stabilization as proposed with the current plans.

We request that these revisions be approved along with the previously submitted information for the basin revisions at the Drainage Board meeting on Tuesday, October 28, 2014. If you should have any questions, or need further information, please contact our office as soon as possible.

Sincerely,

James E. Morley, P.E.

cc: John Stoll - Vanderburgh County Engineer (by email: jstoll@vanderburghgov.org)
Dan Buck
Jeff Stemaly
File

J:\8000s\8600-8699\8699\Civil\Drainage\Final Drainage Report Addendum 2\8699 Additional Revision 10-23-14.doc

4800 Rosebud Lane • Newburgh, IN 47630 • (812) 464-9585 • FAX: (812) 464-2514
www.morleyandassociates.com • e-mail: info@morleyandassociates.com

Open Channel Flow

S200A

Side slope =	0.33		
Bottom width =	2	Flow through Swale =	3.53 cfs
Manning's coefficient =	0.035		
Slope of channel =	0.008		

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.19	0.84	0.44
0.2	2.42	0.52	0.21	0.24	0.71	1.37	0.49
0.3	2.63	0.87	0.33	0.40	1.58	1.82	0.51
0.4	2.84	1.28	0.45	0.57	2.86	2.24	0.52
0.5	3.05	1.75	0.57	0.75	4.60	2.63	0.53
0.6	3.26	2.28	0.70	0.95	6.84	3.00	0.54
0.7	3.47	2.87	0.83	1.17	9.62	3.35	0.55
0.8	3.68	3.52	0.96	1.39	13.00	3.69	0.55
0.9	3.90	4.23	1.09	1.63	17.02	4.02	0.56
1	4.11	5.00	1.22	1.88	21.71	4.34	0.56

Open Channel Flow

S200B

Side slope =	0.33		
Bottom width =	2	Flow through Swale =	3.53 cfs
Manning's coefficient =	0.035		
Slope of channel =	0.2028		

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.98	4.24	2.24
0.2	2.42	0.52	0.21	0.24	3.58	6.88	2.45
0.3	2.63	0.87	0.33	0.40	7.97	9.17	2.57
0.4	2.84	1.28	0.45	0.57	14.42	11.26	2.64
0.5	3.05	1.75	0.57	0.75	23.15	13.23	2.69
0.6	3.26	2.28	0.70	0.95	34.41	15.09	2.73
0.7	3.47	2.87	0.83	1.17	48.44	16.88	2.75
0.8	3.68	3.52	0.96	1.39	65.45	18.60	2.78
0.9	3.90	4.23	1.09	1.63	85.67	20.25	2.80
1	4.11	5.00	1.22	1.88	109.31	21.86	2.81

ASSOCIATES:
James Q. Morley, P.E., P.L.S.
Lee A. McClellan, P.E.
Danny K. Leek, P.L.S.

Morley and Associates Inc.

Engineering ~ Surveying ~ Architecture ~ Construction Management

October 7, 2014

APPROVED
OCT 28 2014
VANDERBURGH COUNTY
DRAINAGE BOARD

Vanderburgh County Surveyor
Attention: Jeff Mueller
Room 325 Civic Center Complex
1 NW MLK Jr, Blvd.
Evansville, IN 47708

Re: Enclave at Eagle Cliff
Revised Drainage Plan Review Comments Response
Morley and Associates, Inc. Project No. 8699.4.001 A

Dear Mr. Mueller,

This letter is in response to your letter dated September 10, 2014 with punchlist items to be addressed for the revised drainage plan for the Enclave at Eagle Cliff. This letter contains information requested along with updated plans addressing the comments and concerns noted in your letter. The following points match and are in order with your bullet points - we have numbered them for ease of any further discussion.

1. Drainage Swale revision summary report: A complete revised drainage report is attached including swale calculations.
2. Basin construction timing: The basins have already been cut in and some vegetation is present. Installation of the concrete liners, additional fine grading, and additional permanent seeding is required to complete the basins. This will be done as soon as possible after approval.
3. Provide a maintenance report for the basin lot owners: The restrictions for the subdivision include information regarding lot owner required maintenance for the basins. An excerpt of the restrictions is attached as part of this submittal for review.
4. Discussion regarding significant storm water drainage: Please see the attached narrative of changes and the effect on adjacent landowners as requested.
5. Swale 202 "V" bottom: The original drainage plan for the subdivision had the roadside ditch bypassing the basin which resulted in a "V" bottom ditch design which was approved. However during construction, the roadside ditch has been routed into the basin and the roadside ditch between the basin and the road is not a "V" bottom ditch, the bottom width varies and is not flat. Pictures of the swale and berm are attached to this letter. The attached plans have revised storage calculation and swale data for the constructed basin and swales in this area. Because this is one area on the site that does have better grass cover and is the most stable, we are requesting that the constructed basin #1 and swales 201 and 202 be approved as a revision to the design plan along with the basin #2 changes. Calculations for the flow data and storage of the installed system is

4800 Rosebud Lane • Newburgh, IN 47630 • (812) 464-9585 • FAX: (812) 464-2514
www.morleyandassociates.com • e-mail: info@morleyandassociates.com

RECEIVED BY THE
VANDERBURGH COUNTY
SURVEYOR'S OFFICE
Received 10/8/2014

attached to this letter. A description of the proposed revisions from the approved plans for this basin are also included in the above mentioned narrative.

6. Basin #2 outflow:
    a. Energy Dissipation: Gabion mattresses shall be installed at the outflow pipe location in order to dissipate the flow velocity from the discharge pipe and to reduce the possibility of the rip rap washing away.
    b. Outflow Velocity: Flow velocity is calculated as V=Q/A, where V is velocity, Q is flow rate in CFS and A is flow area is SF. According to the hydraulic grade line elevations, the average water level is 1 ft above the invert of the pipe. This average depth gives a flow area of 1.26 sq ft. The allowable discharge rate is 12.25 CFS as restricted by the orifice plate on the upstream end of P131. Therefore, the flow velocity is V = 12.25 CFS / 1.26 sq ft. = 9.75 ft/sec which is less than the maximum velocity of 15 ft/sec listed in Section 13.04.230 B of the drainage ordinance. Calculations for the flow velocity are attached to this letter.
7. Compaction Methods for Basin #2: The developer informed us that the fill placed for the basin and berm was compacted in lifts with a roller when the basin was installed.
8. Erosion protection of basin berm slope: The majority of the berm has been constructed and seeded. Currently the berm has a some vegetation on the slopes, but fine grading and re-seeding is required. The outfall pipe shall have gabion mattresses to dissipate energy and prevent erosion at the outlet. When additional work is performed for the basin that will disturb the current ground cover, the slopes shall be stabilized with erosion control blanket with permanent seeding until permanent stable vegetation is achieved.
9. Emergency overflow channelization: The emergency overflow will discharge across the face of the berm until the contours at the rear of Lot 27 begin to channelize. The water will flow over the slope of the berm for approximately 45' until it begins to channelize with the contours. Rip rap will be installed the entire width of the emergency overflow to the point where the contours begin to channelize, at which point the rip rap will be installed to follow the contour channelization.
10. Swale 210 energy dissipation: Rip rap is proposed to dissipate the energy from Swale 210 as it enters the dry basin as shown on C104.
11. Minimum Finished Floor (FF) elevations: Minimum FF elevations have been added to the plan for Lots 13-17 and 23-27.
12. Drainage Easements: Additional lake maintenance and storm drainage easement has been added to lots 13 and 27 as requested.
13. Access to P131: Additional access for P131 is achieved by the additional easement noted above.
14. Additional rip rap: Rip rap has been shown on sheet C104 for S200 and S210 as requested.

4800 Rosebud Lane • Newburgh, IN 47630 • (812) 464-9585 • FAX: (812) 464-2514
www.morleyandassociates.com • e-mail: info@morleyandassociates.com

15. Remaining tree debris removal: The developer has informed us that he intends to either haul the tree debris off site or it will be buried in non-buildable areas of the property and that none of the material will be placed in basin #2.

16. Steep slopes of lots 13, 14, 26, and 27: Sheet C104 has been updated to include erosion control blankets on the slopes of Lots 13, 14, 26, and 27 as requested. The blanketed area also includes the slope of the berm once it is final graded and seeded.

17. Rip rap at flat slope pipe outfalls: We have shown rip rap at all pipe outfalls in order to maintain a stable outfall. FES 116 will discharge a high flow rate from the commercial area even though the pipe is at a minimal slope, therefore rip rap outfall protection is provided. FES 121 carries the flow from nearly 5.5 acres of the site, therefore, for the flow rate alone, we have placed rip-rap at the outfall. FES 121 and 129 outfall into the basin at the basin discharge pipe in opposite directions. Due to the turbulent flow that will be present when both of the pipes are discharging water into the basin and then turning 90 degrees to flow out of the basin, riprap is shown across the entire end of the basin around all of those flared end sections. FES 126 discharges perpendicular to the swale flow line. Even though the slope of the pipe and velocity of the water are small, rip rap is shown to protect the side slopes of the swale where the water will be turning to flow down the swale.

18. Average Slopes notes: Additional notes have been added to the plans as requested.

19. Confidentiality Statement: The statement in our title block has been updated.

The developer has hired Redwing Ecological Services to provide data and plans for the Indiana Department of Environmental Management (IDEM) and the US Army Corps of Engineers (USACE). Redwing will be copied on this information and will coordinate the submittal and approval by IDEM and USACE on behalf of the developer.

Notice of the October 14, 2014 Drainage Board meeting has been mailed to adjoining land owners on September 26, 2014 in accordance with the requirements noted on the September 8, 2014 email from Ron London.

Sincerely,

James E. Morley, P.E.

JAMES E. MORLEY REGISTERED No. 10100250 STATE OF INDIANA PROFESSIONAL ENGINEER

10-7-14

cc: John Stoll - Vanderburgh County Engineer
Redwing - Richard Clausen
Dan Buck
File

J:\8000s\8600-8699\8699\Civil\Drainage\Final Drainage Report Addendum 2\Addendum 2 punchlist response\Addendum 2 Punchlist Response..doc

4800 Rosebud Lane • Newburgh, IN 47630 • (812) 464-9585 • FAX: (812) 464-2514
www.morleyandassociates.com • e-mail: info@morleyandassociates.com

Excerpt from Covenants and Restrictions of the Subdivision to address maintenance of Drainage Basins.

by any grantee shall be construed to be acceptance and an affirmance by said grantee of restrictions aforesaid, whether or not the same be set out or specified in such conveyance to grantee.

24. INJUNCTIVE RELIEF. Each and all of the covenants, reservations, conditions and restrictions contained herein shall inure to the benefit of all Owners of Lots in this Subdivision jointly and severally, and may be enforced by them or by any of them and the Association herein established in any court of competent jurisdiction by injunction or other appropriate remedy. The party adjudged to have violated any of said matter shall pay the enforcing parties reasonable attorneys' fees and cost incurred in the enforcement thereof. The Owner of any Lot in this Subdivision and the Association, shall have the right to enforce said covenants, conditions and restrictions without proof of pecuniary damage to Owners Lot in this Subdivision or otherwise.

25. PASSAGEWAY. No Owner shall permit or authorize anyone to use a portion of any Lot as a passageway or means of ingress or egress to or from any contiguous property, nor shall any utility easements be granted without the approval of the Developer.

26. CHANGING OF LOT DIMENSIONS. It is expressly understood and agreed that the Developer or Builder, shall have the right to change, alter, adjust or readjust the dimensions of any Lot owned by the Developer or Builder without the consent of other Lot Owners in the Subdivision.

27. MAILBOXES. All Mailboxes shall be uniform in appearance. The box will be a medium size regulation U.S. Postal Service approved box. Replacement mailboxes will match or closely match the originally installed mailbox and post.

28. DRAINAGE AND DRAINAGE REPAIR. The individual Lot Owners shall be responsible, including financially, for maintaining that part of the storm water drainage system and its easements which exists on Owners Lot in proper working order including;

a. Mowing grass, controlling weeds, and maintaining the designed cover, the waterways, storage basins, and easements in accordance with applicable ordinances.
b. Keeping all parts of the storm water drainage system operating as designed and constructed; and free of all trash, debris, and obstructions to the flow of water.
c. Keeping the channels, embankments, shorelines, and bottoms of waterways and basins free of all erosion and sedimentation.
d. Maintaining that part of the storm water drainage system in accordance with the conditions described on the approved street and or drainage plans on file in the Vanderburgh County Drainage Ordinance.
e. Preventing all persons or parties from causing any unauthorized alterations, obstructions, or detrimental actions from occurring to any part of the storm water drainage system and easement which lies on his or her property.
f. The Repair Fund, paid by the Developer to Vanderburgh County, establish for this project will pay the costs of repairing structural failures in the storm sewer pipes, pipe collars, drip boxes, aprons, inlets, manhole, junction boxes, and the piped or paved outlet structures of the storm water control basins all of which are parts of the approved and constructed storm water drainage system shown on the as-built plans for this Subdivision; and which are in drainage easements and outside of the Vanderburgh County accepted road rights-of-way as shown on the plat of this Subdivision.

29. HOMEOWNER'S ASSOCIATION. For the purpose of maintaining the appearance of the drainage plan, easements, water detention basin and entranceway improvements, there shall be created an association of the Owners of the Lots in this Subdivision which shall include all phases of The Orchard

Bethany Hopf

From: Bethany Hopf
Sent: Monday, September 15, 2014 8:17 AM
To: 'Mueller, Jeffrey'; Stoll, John
Cc: James E. Morley
Subject: RE: 8699 - Enclave at Eagle Cliff

Jeff,
The outflow pipe has an orifice plate on it to restrict the flow. The outflow of the orifice is based on the orifice calculation, not a pipe flow calculation, therefore the slope of the pipe does not affect the outflow volume of the orifice. Calculations for the orifice outflow volume are provided in the package I sent you in the mail last week if it wasn't included in the original submittal back in May.

Thank you.

Bethany S. Hopf, P.E.

Morley and Associates, Inc.
4800 Rosebud Lane
Newburgh, IN 47630
Phone: (812) 464-9585

From: Mueller, Jeffrey [mailto:jmueller@vanderburghsurveyor.com]
Sent: Monday, September 15, 2014 8:11 AM
To: Bethany Hopf; Stoll, John
Cc: James E. Morley
Subject: RE: 8699 - Enclave at Eagle Cliff

Bethany,

In addition to the letter I have one other question. On Basin 2, the outflow shown is the same as when previously submitted even though the outflow is now through a pipe on a much steeper slope. This does not seem possible. Can you please check this calculation/the formula being used?

Thanks

Jeff

From: Bethany Hopf [mailto:bethanyh@morleyandassociates.com]
Sent: Thursday, September 11, 2014 4:40 PM
To: Stoll, John; Mueller, Jeffrey
Cc: James E. Morley
Subject: 8699 - Enclave at Eagle Cliff

Jeff and John,
I mailed out revised drainage information for you the other day since IDEM gave approval to build homes. Then today I got your letter that you have now reviewed the plans we submitted back in May. You can disregard the items you will be receiving in the mail as they are the same plans you just reviewed. I will tak a look at your punchlist letter and get back with you as soon as possible.

APPROVED

OCT 2 8 2014

VANDERBURGH COUNTY DRAINAGE BOARD

FINAL DRAINAGE REPORT REVISED

for

Enclave at Eagle Cliff
Vanderburgh County, Indiana

Project No.: 8699.6.001 A
October 7, 2014

Prepared For:

Eagle Enclave Development, LLC
PO Box 4530
Evansville, IN 47724-0530

Prepared By:

Morley and Associates, Inc.
4800 Rosebud Lane
Newburgh, Indiana 47630
Phone: (812) 464-9585
Fax: (812) 464-2514

JAMES E. MORLEY
REGISTERED
No. 10100250
STATE OF
INDIANA
PROFESSIONAL ENGINEER

10-7-14

Morley and Associates Inc.

10/8/2014

Enclave at Eagle Cliff (REVISED 10-7-14)

Revisions from originally approved drainage plan are highlighted in RED text.

Site Location

The site is located on the southwest corner of SR 62 (Lloyd Expressway) and Felstead Road. The site is a part of the West Half of the Southeast Quarter of Section 29, Township 6 South, Range 11 West in Perry Township, Vanderburgh County, Indiana. The site is bordered by an apartment complex and undeveloped wooded land to the west, Felstead Road to the east, SR 62 to the north and undeveloped wooded land to the south.

Soil Properties

The most recent USDA Soil Survey for Vanderburgh County indicates the presence of the following soil types: Alford silt loam, 6 to 12 percent slopes, severely eroded (AlC3); Hosmer silt loam, 2 to 6 percent slopes, eroded (HoB2); Wellston silt loam, 12 to 18 percent slopes, severely eroded (WeD3); Wellston silt loam, 18 to 25 percent slopes, eroded (WeE2); and Wilbur silt loam (Wm).

Proposed Development

The proposed development (22.65 acres) will contain 56 single family residences, one commercial lot and one lot that will not be developed. The undeveloped lot is planned to be sold to the adjoiner as an extension of the adjoining "yard". The residential project will include homes with attached garages, driveways, patios, landscaped areas, streets, a network of drainage swales and storm sewers, and two dry detention basins. The commercial project is not yet defined at this time, however the drainage runoff from commercial use has been estimated for the site and is accounted for in the drainage basin sizing.

Flood Plain Data

The proposed subdivision does not fall within the limits of the 100-year flood zone as plotted by scale on the Flood Insurance Rate Map for Vanderburgh County, Indiana, Community Panel Number 18163C0175D dated March 17, 2011.

Existing Drainage Conditions

The site is currently utilized partially as an open pasture and partially woodland. Site terrain consists of approximately 1% flat (slope less than 2%), 40% moderate (2% to 5%), 40% rolling (5%-10%), and 19% hilly (slope over 10%). The site currently drains to the northeast, west and south. Six onsite drainage subbasins were used to estimate the undeveloped onsite runoff based on the 10-year storm event. An overall undeveloped runoff rate of **45.78 CFS** was determined for the entire 22.65 acres with an overall weighted C value of 0.41. No offsite water comes onto the site because the site is the top of the ridge lines.

Proposed Drainage Conditions

The overall drainage design calls for 64% of the site to drain to the two detention basins planned for the subdivision. Twenty-nine onsite drainage subbasins were used to

estimate the developed onsite runoff. Runoff of onsite subbasins 1, 9, 10, 11, 26, 28 and 29 will leave the site undetained to existing points of discharge. Subbasins 9, 10, 26 and 29 will not be significantly developed and have not been calculated for the 25 year storm. An overall developed runoff rate of 54.59 CFS was determined for subbasins 1-8, 11-25 and 28 for the 25 year storm. A runoff rate of 20.90 CFS was determined for subbasins 9, 10, 26 and 29 for the 10 year storm. A total of **75.49 CFS** will be used for the total developed site (22.65 Ac.) runoff before detention with an overall C value of 0.53.

The total undetained runoff for the developed site (subbasins 1, 11, and 28 for the 25 year storm and subbasins 9.1, 9.2, 10, 26 and 29 for the 10 year storm) is **26.28 CFS**. Runoff from subbasins 3, 4, 5, 7, 8, and 17 will drain to Dry Basin #1 and will be released from the basin at a reduced rate to partially account for the undetained runoff from the site. Runoff from subbasins 2, 6, 12-16, 18-25 and 27 will drain to Dry Basin #2 and will be released from the basin at a reduced rate to partially account for the undetained runoff from the site.

The total allowable release from the basins is the pre-developed 10 year runoff rate minus the undetained developed runoff rate (45.78 - 26.28) = **19.50 CFS** total. Dry Basin #1 will release at a much smaller rate than Dry Basin #2 in an attempt to maintain minimal changes to the overall discharge to the existing outlets.

In existing conditions, a total of 7.23 CFS drains from subbasins U1 and U2 to the Felstead Road and SR 62 roadside ditches. In developed conditions, subbasin 1 discharges 1.91 CFS undetained to the roadside ditches during the 25 year storm. Therefore Dry Basin #1 can discharge up to 5.32 CFS without exceeding existing 10 year storm flow rates in the roadside ditches. Additionally the roadside ditch has been routed into the basin. The 10year flow rate for the subbasin 9.1 is 0.82 CFS. This water will be routed into the basin but does not require storage since the road is not being improved. The flow from subbasin 9.1 is simply a pass through which increases the allowable discharge from Basin #1 to 5.32+0.82 = 6.14 CFS. The pipe draining Dry Basin #1 is a 12" pipe. Under 4' of head a 12" pipe will discharge more than the allowable 5.32 CFS therefore an orifice plate with a 11.00" diameter opening will be installed on the upstream end of P 101 to restrict the flow to only 6.08 CFS to meet the requirements of the Drainage Ordinance.

In existing conditions, a total of 31.46 CFS drains from subbasins U3, U4 and U5 to the west and south. In developed conditions, subbasins 11, 28 and 29 runoff undetained. As mentioned above, subbasin 29 will be only minimally developed and therefore is calculated for the 10 year storm. The undetained runoff totals ($3.42_{\text{25 yr undetained dev subbasins 11 \& 28}}$ + $15.74_{\text{10 yr undetained dev subbasin 29}}$) = 19.16 CFS. The allowable release rate for Dry Basin #2 is (31.46 - 19.16) = 12.30 CFS during the 25 year storm. The pipe draining Dry Basin #2 is an 18" pipe. Under 4' of head an 18" pipe will discharge more than the allowable 12.48 CFS therefore an orifice plate with a 16.00" diameter opening will be installed on the upstream end of P 131 to restrict the flow to only 12.25 CFS to meet the requirements of the Drainage Ordinance.

RECEIVED BY
EMAIL 10/13/2014 1:39

estimate the developed onsite runoff. Runoff of onsite subbasins 1, 9, 10, 11, 26, 28 and 29 will leave the site undetained to existing points of discharge. Subbasins 9, 10, 26 and 29 will not be significantly developed and have not been calculated for the 25 year storm. An overall developed runoff rate of 54.59 CFS was determined for subbasins 1-8, 11-25 and 28 for the 25 year storm. A runoff rate of 20.90 CFS was determined for subbasins 9, 10, 26 and 29 for the 10 year storm. A total of **75.49 CFS** will be used for the total developed site (22.65 Ac.) runoff before detention with an overall C value of 0.53.

The total undetained runoff for the developed site (subbasins 1, 11, and 28 for the 25 year storm and subbasins 9.1, 9.2, 10, 26 and 29 for the 10 year storm) is **26.28 CFS.** Runoff from subbasins 3, 4, 5, 7, 8, and 17 will drain to Dry Basin #1 and will be released from the basin at a reduced rate to partially account for the undetained runoff from the site. Runoff from subbasins 2, 6, 12-16, 18-25 and 27 will drain to Dry Basin #2 and will be released from the basin at a reduced rate to partially account for the undetained runoff from the site.

The total allowable release from the basins is the pre-developed 10 year runoff rate minus the undetained developed runoff rate (45.78 - 26.28) = **19.50 CFS** total. Dry Basin #1 will release at a much smaller rate than Dry Basin #2 in an attempt to maintain minimal changes to the overall discharge to the existing outlets.

In existing conditions, a total of 7.23 CFS drains from subbasins U1 and U2 to the Felstead Road and SR 62 roadside ditches. In developed conditions, subbasin 1 discharges 1.91 CFS undetained to the roadside ditches during the 25 year storm. Therefore Dry Basin #1 can discharge up to 5.32 CFS without exceeding existing 10 year storm flow rates in the roadside ditches. Additionally the roadside ditch has been routed into the basin. The 10year flow rate for the subbasin 9.1 is 0.82 CFS. This water will be routed into the basin but does not require storage since the road is not being improved. The flow from subbasin 9.1 is simply a pass through which increases the allowable discharge from Basin #1 to 5.32+0.82 = 6.14 CFS. The pipe draining Dry Basin #1 is a 12" pipe. Under 4' of head a 12" pipe will discharge more than the allowable 5.32 CFS therefore an orifice plate with a 11.00" diameter opening will be installed on the upstream end of P 100 to restrict the flow to only 6.08 CFS to meet the requirements of the Drainage Ordinance.

In existing conditions, a total of 31.46 CFS drains from subbasins U3, U4 and U5 to the west and south. In developed conditions, subbasins 11, 28 and 29 runoff undetained. As mentioned above, subbasin 29 will be only minimally developed and therefore is calculated for the 10 year storm. The undetained runoff totals ($3.42_{\text{25 yr undetained dev subbasins 11 \& 28}}$ + $15.74_{\text{10 yr undetained dev subbasin 29}}$) = 19.16 CFS. The allowable release rate for Dry Basin #2 is (31.46 - 19.16) = 12.30 CFS during the 25 year storm. The pipe draining Dry Basin #2 is an 18" pipe. Under 4' of head an 18" pipe will discharge more than the allowable 12.48 CFS therefore an orifice plate with a 16.00" diameter opening will be installed on the upstream end of P 131 to restrict the flow to only 12.25 CFS to meet the requirements of the Drainage Ordinance.

The total allowable release rate from the basins calculated above as 19.50 is greater than the actual release rate from the basins. 19.50 > 18.33 (6.08 + 12.25). Form 800 calculations for the two detention basins were carried out for the 25-year storm event. The discharge rates of the two detention basins were reduced as noted above. Each basin has capacity to retain the required amount of storm water.

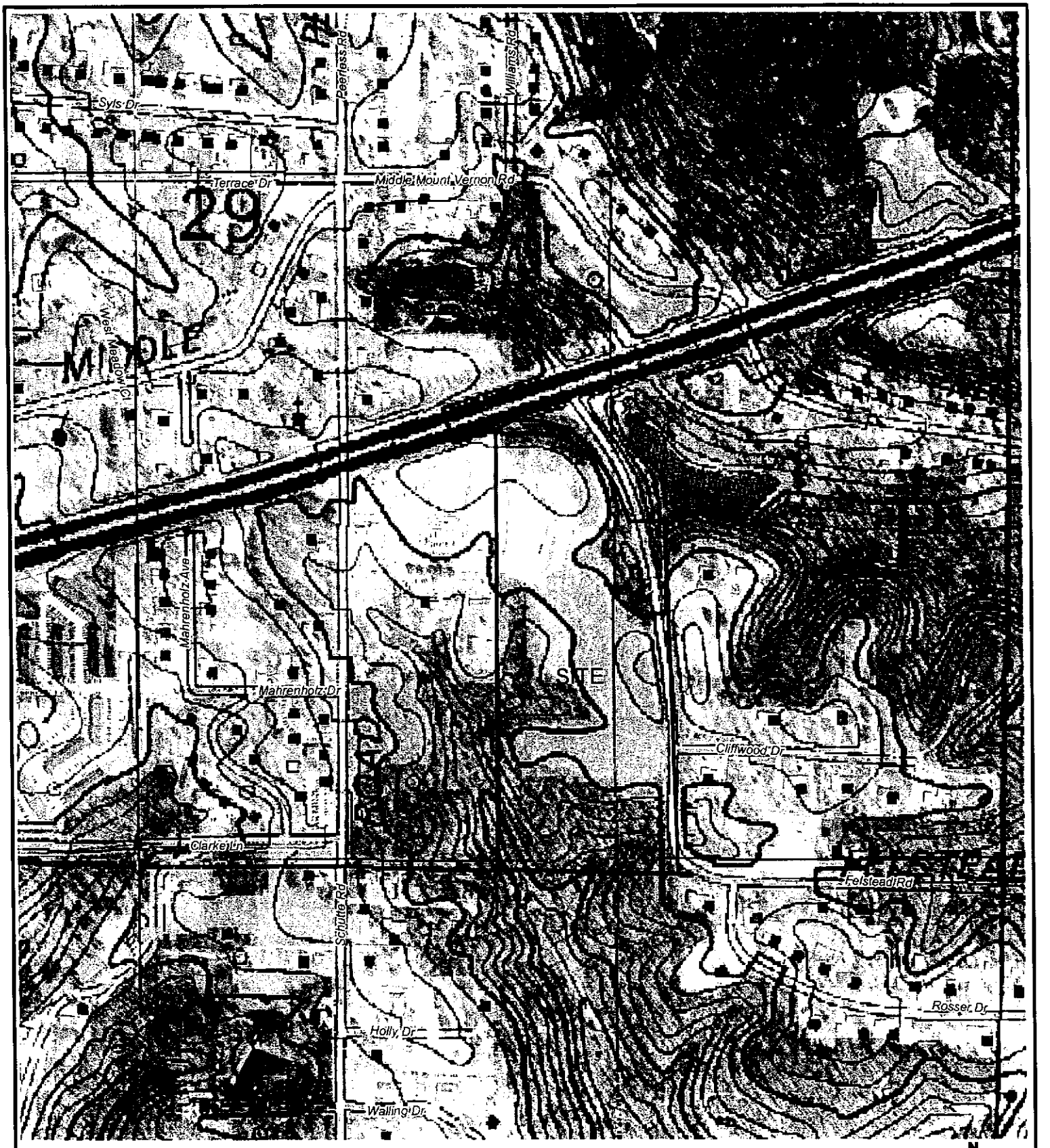
Description and explanation of revisions

Basin #1 was originally designed to separate the Felstead Road roadside ditch from the development storm runoff. The roadside ditch was not originally designed to flow into the basin however, during construction, the ditch was routed into the basin. Therefore revisions were made to the calculations for Basin #1 to allow for pass through of the roadside ditch flow. Calculations for the as-built storage capacity are included and based on actual constructed elevations and basin shape/size. We are requesting the constructed basin #1 to be approved as a revision to the drainage plan because this basin and the berm slopes are one of the few areas on the site that are fairly stable and has vegetation cover that is substantially better than anywhere else. If the existing basin is required to be disturbed, the work would present an unnecessary increased risk of downstream sedimentation since the basin is functional and has more than the required storage capacity.

Basin #2 revisions from originally approved plans include moving the basin further east and away from the west property line. This created a taller and longer slope on the back side of the berm. Because the basin has moved further from the property line, there is a larger area that runs off undetained. The increased undetained runoff is counter balanced by a reduced outflow rate from the basin. The overall discharge from the development of a 25 year storm event is less than the pre-developed site 10 year storm event per the Drainage Ordinance. Therefore, the changes proposed in this addendum do not adversely affect adjoining property owners compared to the originally designed plan. After work on the basin is completed, the slopes shall be stabilized with erosion control blanket until stable vegetative cover is achieved. The developer shall monitor the site for erosion and shall address erosion problems as soon as possible in order to prevent offsite sedimentation.

Index

1. Quadrangle Map



Morley and Associates Inc.

Engineering
Surveying
Architecture
Construction Management

Evansville, In
(812) 464-9585

Henderson, Ky
(270) 830-0300

Jasper, In
(812) 634-9990

www.morleyandassociates.com

N
W E
S

1 inch = 500 feet

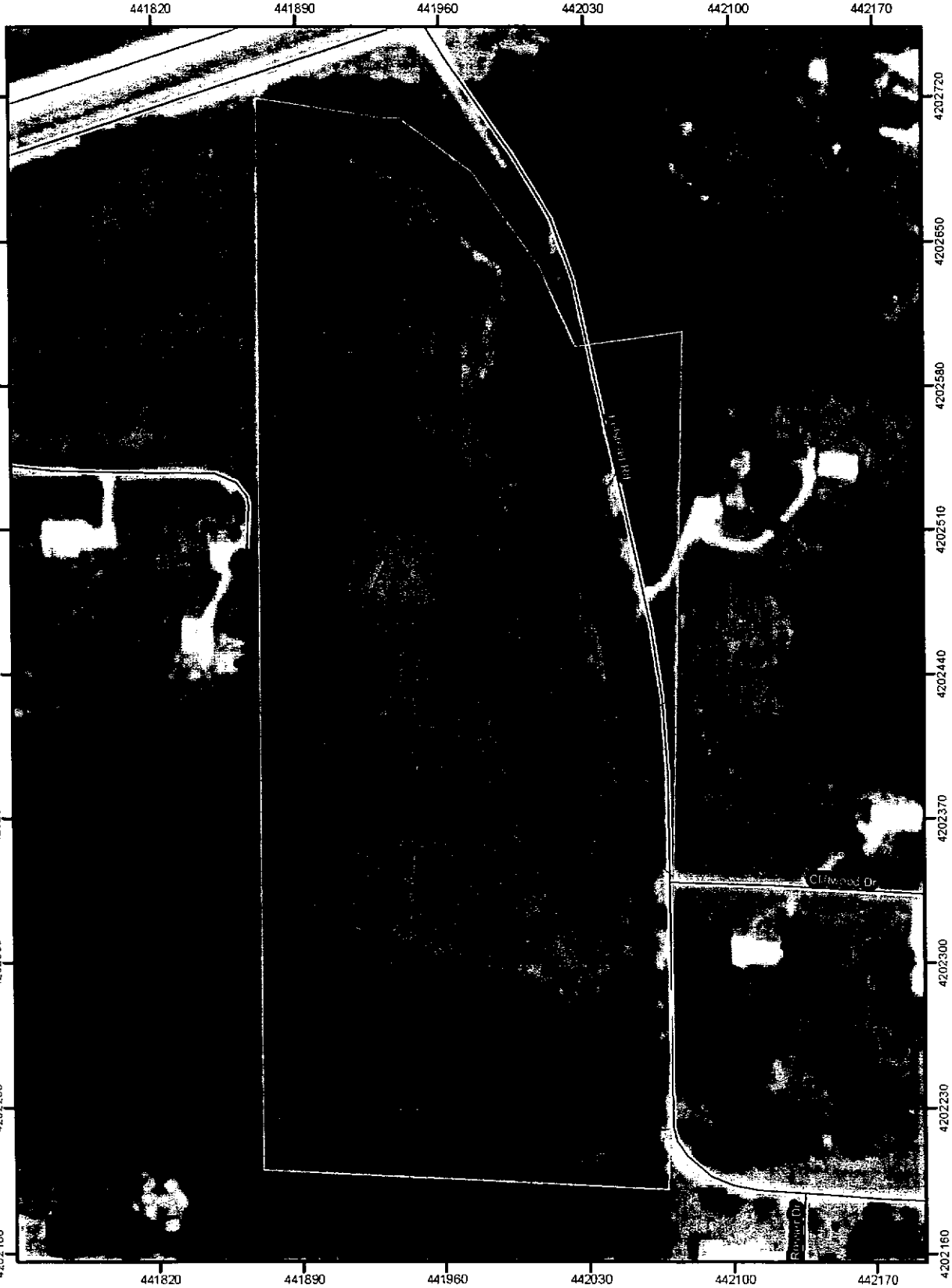
USGS Quadrangle Map
Vanderburgh County

Designed By	Job Number
BSH	8699.6.001 A
Drawn By	Date
BSH	12-21-12

Filename J:\8699\Civil\Drainage\Quad Map.pdf

2. Soil Survey for Vanderburgh County

Soil Map—Vanderburgh County, Indiana
(Enclave at Eagle Cliff)



Map Scale: 1:2,850 if printed on A size (8.5" x 11") sheet.

N

Meters
0 25 50 100 150

Feet
0 100 200 400 600

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Streams and Canals

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

MAP INFORMATION

Map Scale: 1:2,850 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:15,840.

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 16N NAD83

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

Soil Survey Area: Vanderburgh County, Indiana
Survey Area Data: Version 12, Dec 13, 2011

Date(s) aerial images were photographed: 7/13/2003

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.

Map Unit Legend

Vanderburgh County, Indiana (IN163)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AlB2	Alford silt loam, 2 to 6 percent slopes, eroded	0.1	0.5%
AlC3	Alford silt loam, 6 to 12 percent slopes, severely eroded	9.5	40.1%
HoB2	Hosmer silt loam, 2 to 6 percent slopes, eroded	9.1	38.7%
WeD3	Wellston silt loam, 12 to 18 percent slopes, severely eroded	1.6	6.6%
WeE2	Wellston silt loam, 18 to 25 percent slopes, eroded	3.2	13.4%
Wm	Wilbur silt loam	0.2	0.6%
Totals for Area of Interest		**23.6**	**100.0%**

3. FIRM Map

$^{42}03^{000m}N$

Approximate Site Limits

$^{42}02^{000m}N$

$^{42}01^{000m}N$

THIS AREA S
1" = 500' ON MA

$^{42}00^{000m}N$

ZONE AE
(EL 376)

2790000 FT

MAP SCALE 1" = 2000'

000 0 2000 4000

FEET

METER

PANEL 0175D

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

VANDERBURGH COUNTY, INDIANA
AND INCORPORATED AREAS

PANEL 175 OF 275

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS

COMMUNITY	NUMBER	PANEL	SUFFIX
VANDERBURGH COUNTY	180256	0175	D

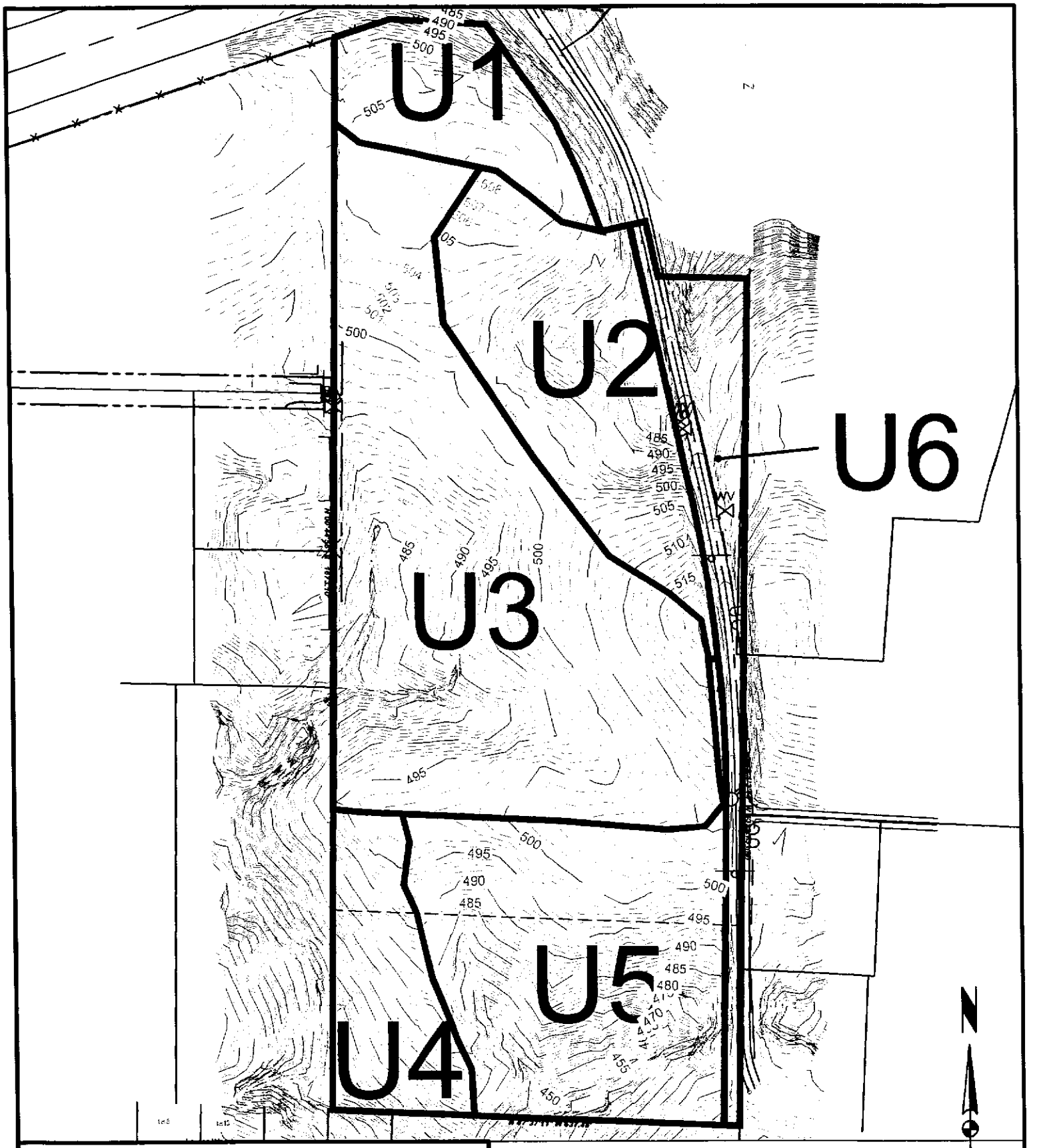
Notice to User The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
18163C0175D

EFFECTIVE DATE
MARCH 17, 2011

Federal Emergency Management Agency

4. Pre-Developed Drainage Information



Morley and Associates Inc.
Engineering
Surveying
Architecture
Construction Management
Evansville, In
(812) 464-9585
Henderson, Ky (270) 830-0300
Jasper, In (812) 634-9990
www.morleyandassociates.com

Enclave at Eagle Cliff
Pre-Developed Drainage Subbasins

Designed By: JEM	Job Number: 8699.6.001 A
Drawn By: BSH	Date: 5-8-13
Filename: J:/8699/Civil/8699 Base.dwg	

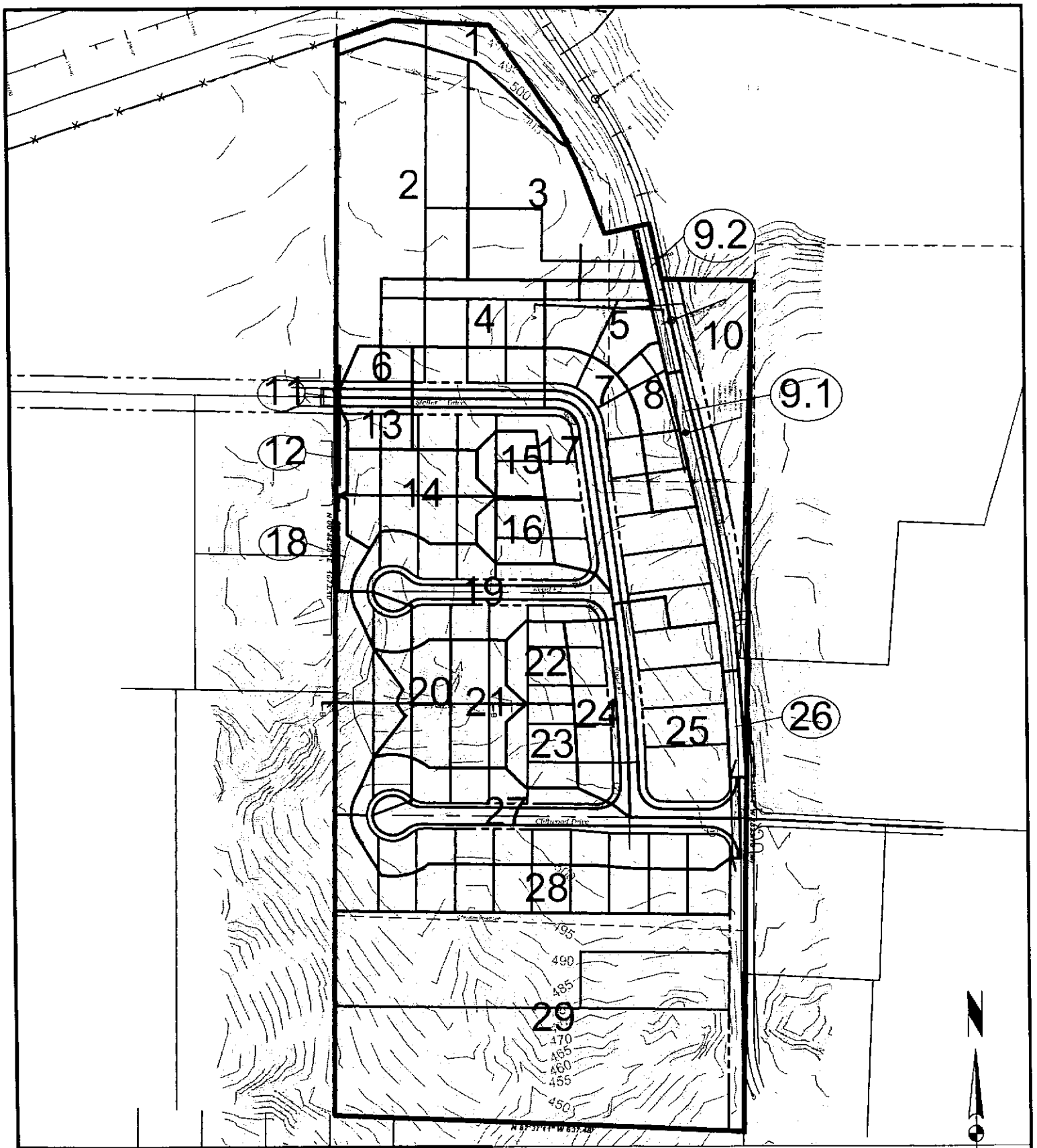
Pre-Developed Drainage Subbasins

Sub-basin	Area (S.F.)	Structures (S.F.)	Pavement (S.F.)	Lawn (<2%) (S.F.)	Lawn (2-5%) (S.F.)	Lawn (5%-10%) (S.F.)	Woodland Rolling (5-10%) (S.F.)	Woodland Hilly (10-30%) (S.F.)	Pasture Flat (S.F.)	Pasture Rolling (S.F.)	Sheet Flow L (ft)	Sheet Flow H (ft)	Channel Flow L (ft)	Channel Flow H (ft)
U1	72,137	0	0	0	0	0	22,727	0	31,865	17,545	100.0	0.75	361.0	26.00
U2	153,932	0	0	0	0	0	101,725	0	50,694	1,513	100.0	1.00	371.2	24.50
U3	393,145	0	0	0	0	0	0	92,444	0	300,701	100.0	2.00	835.5	36.00
U4	74,107	0	0	0	0	0	0	74,107	0	0	100.0	3.50	145.1	28.50
U5	213,759	0	0	0	0	0	0	156,703	0	57,056	100.0	5.00	767.3	66.25
U6	79,322	0	19,405	0	0	0	0	59,917	0	0	10.1	0.50	634.0	53.00

Pre-Developed Drainage Subbasins

Subbasin	Area (ac.)	Weighted C	Weighted N	Sheet Flow S (%)	Open Channel S (%)	Sheet Flow tc (minutes)	Channel tc (minutes) (min 5.0)	Sum tc (minutes) (min 5.0)	I(5) (in/hr)	Q(5) (CFS)	I(10) (in/hr)	Q(10) (CFS)
U1	1.66	0.31	0.46	0.75%	7.20%	15.60	0.63	16.23	3.93	2.00	4.41	2.24
U2	3.53	0.32	0.53	1.00%	6.60%	15.56	0.68	16.25	3.93	4.45	4.41	4.99
U3	9.03	0.39	0.45	2.00%	4.31%	12.20	1.90	14.10	4.18	14.64	4.67	16.36
U4	1.70	0.48	0.60	3.50%	19.64%	12.29	0.15	12.44	4.46	3.64	4.96	4.05
U5	4.91	0.45	0.55	5.00%	8.63%	10.82	1.23	12.06	4.52	9.94	5.02	11.05
U6	1.82	0.59	0.46	4.94%	8.36%	3.43	1.03	5.00	6.06	6.49	6.63	7.09

5. Developed Drainage Information



SCALE 1" = 200'

200 0 200 400

Morley and Associates Inc.

Engineering
Surveying
Architecture
Construction Management

Evansville, In
(812) 464-9585

Henderson, Ky (270) 830-0300

Jasper, In (812) 634-9990

www.morleyandassociates.com

Enclave at Eagle Cliff
Developed Drainage Subbasins - REVISED

Designed By: JEM	Job Number: 8699.6.001 A
Drawn By: BSH	Date: 10-7-14
Filename: J:/8699/Civil/8699 Base.dwg	

REVISED

Developed Drainage Subbasins

Subbasin	Area (ac.)	Weighted C	Weighted N	Sheet Flow S (%)	Open Channel S (%)	Sheet Flow tc (minutes)	Channel tc (minutes) (min 5.0)	Sum tc (minutes) (min 5.0)	I(5) (in/hr)	Q(5) (CFS)	I(10) (in/hr)	Q(10) (CFS)	I(25) (in/hr)	Q(25) (CFS)
1	0.33	0.80	0.21	15.45%	5.41%	4.11	0.47	5.00	6.06	1.60			7.21	1.91
2	1.88	0.80	0.16	2.00%	2.00%	7.56	1.50	9.06	5.09	7.64			6.17	9.26
3	1.26	0.80	0.16	2.00%	1.98%	7.56	1.53	9.09	5.08	5.14			6.16	6.23
4	0.61	0.80	0.15	2.00%	5.93%	7.28	0.49	7.77	5.40	2.65			6.50	3.19
5	0.45	0.36	0.71	9.95%	4.75%	10.00	0.32	10.32	4.81	0.77			5.87	0.94
6	0.19	0.61	0.35	2.27%	2.45%	8.74	0.34	9.08	5.08	0.58			6.16	0.70
7	1.46	0.50	0.46	1.98%	1.67%	10.17	2.05	12.22	4.49	3.30			5.53	4.06
8	0.36	0.42	0.61	2.01%	8.88%	10.90	0.41	11.31	4.64	0.69			5.69	0.85
9.1	0.27	0.47	0.49	3.52%	6.20%	4.50	0.91	5.41	5.96	0.75	6.52	0.82		
9.2	0.13	0.47	0.49	3.52%	4.85%	4.50	0.22	5.00	6.06	0.38	6.63	0.42		
10	1.01	0.55	0.51	8.85%	8.52%	3.33	1.00	5.00	6.06	3.37	6.63	3.68		
11	0.00	0.92	0.02	3.06%	0.00%	1.09	0.00	5.00	6.06	0.02			7.21	0.03
12	0.05	0.21	1.00	14.15%	4.00%	4.06	0.30	5.00	6.06	0.07			7.21	0.08
13	0.19	0.59	0.36	2.27%	2.51%	8.94	0.34	9.28	5.04	0.58			6.11	0.70
14	0.67	0.37	0.59	12.14%	1.30%	7.88	0.89	8.76	5.16	1.29			6.24	1.56
15	0.21	0.35	0.62	2.78%	5.87%	11.40	0.12	11.52	4.61	0.35			5.65	0.42
16	0.25	0.32	0.64	12.06%	1.00%	9.43	0.33	9.75	4.92	0.40			5.99	0.49
17	0.79	0.53	0.43	2.50%	2.53%	9.48	0.81	10.29	4.81	2.00			5.87	2.44
18	0.10	0.27	0.70	49.50%	2.79%	1.91	0.42	5.00	6.06	0.16			7.21	0.19
19	1.15	0.54	0.42	2.67%	4.35%	7.03	0.84	7.88	5.37	3.34			6.47	4.03
20	0.38	0.37	0.59	15.70%	4.04%	7.88	0.41	8.29	5.27	0.75			6.36	0.90
21	0.42	0.31	0.66	6.63%	14.54%	11.06	0.11	11.17	4.67	0.61			5.72	0.74
22	0.27	0.35	0.62	13.39%	1.00%	7.56	0.44	8.01	5.34	0.50			6.44	0.60
23	0.31	0.33	0.64	3.23%	1.60%	12.14	0.36	12.49	4.45	0.45			5.48	0.55
24	0.52	0.54	0.41	2.18%	2.62%	9.63	0.65	10.28	4.82	1.36			5.87	1.66
25	1.17	0.47	0.50	2.00%	2.15%	10.48	1.08	11.56	4.60	2.50			5.65	3.07
26	0.09	0.47	0.49	3.52%	1.10%	4.50	0.76	5.26	6.00	0.27	6.56	0.29		
27	1.66	0.57	0.39	13.20%	1.21%	3.04	2.66	5.70	5.90	5.54			7.03	6.60
28	1.59	0.33	0.64	23.43%	0.00%	7.81	0.00	7.81	5.39	2.82			6.49	3.39
29	4.86	0.50	0.57	7.20%	9.65%	4.88	0.89	5.77	5.88	14.38	6.43	15.74		

REVISED

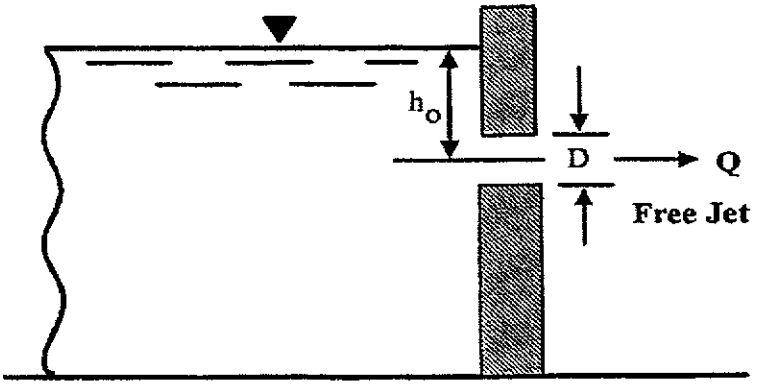
REVISED

Developed Drainage Subbasins

Sub-basin	Area (S.F.)	Structures (S.F.)	Pavement (S.F.)	Lawn (<2%) (S.F.)	Lawn (2-5%) (S.F.)	Lawn (5%-10%) (S.F.)	Woodland Rolling (5-10%) (S.F.)	Woodland Hilly (10-30%) (S.F.)	Pasture Flat (S.F.)	Pasture Rolling (S.F.)	Sheet Flow L (ft)	Sheet Flow H (ft)	Open Channel Flow L (ft)	Open Channel Flow H (ft)
1	14,500	0	11,020	0	0	3,480	0	0	0	0	58.3	9.00	232.3	12.58
2	81,867	0	67,131	0	14,736	0	0	0	0	0	100.0	2.00	449.6	9.00
3	55,090	0	45,174	0	9,916	0	0	0	0	0	100.0	2.00	454.8	9.00
4	26,775	15,850	6,540	3,289	1,096	0	0	0	0	0	100.0	2.00	252.9	15.00
5	19,431	2,200	0	5,165	4,308	7,758	0	0	0	0	91.4	9.10	147.5	7.00
6	8,125	2,200	2,538	2,541	847	0	0	0	0	0	67.5	1.53	113.4	2.78
7	63,779	14,850	13,152	26,833	8,944	0	0	0	0	0	65.8	1.30	562.0	9.40
8	15,629	3,850	0	0	11,779	0	0	0	0	0	57.9	1.16	258.0	22.91
9.1	11,739	0	4,622	5,337	1,779	0	0	0	0	0	14.2	0.50	480.0	29.76
9.2	5,869	0	2,311	2,669	890	0	0	0	0	0	14.2	0.50	103.0	5.00
10	43,922	7,117	0	0	0	0	0	36,805	0	0	11.5	1.02	616.0	52.45
11	174	0	174	0	0	0	0	0	0	0	15.7	0.48	0.0	0.00
12	2,295	0	0	2,295	574	0	0	0	0	0	11.2	1.59	128.6	5.14
13	8,443	2,200	2,538	2,779	926	0	0	0	0	0	67.5	1.53	113.4	2.85
14	29,263	7,700	0	16,172	5,391	0	0	0	0	0	72.6	8.81	214.0	2.78
15	9,319	2,200	0	5,339	1,780	0	0	0	0	0	73.9	2.05	61.0	3.58
16	11,046	2,200	0	6,634	2,211	0	0	0	0	0	98.0	11.82	69.0	0.69
17	34,302	6,050	10,169	13,562	4,521	0	0	0	0	0	67.5	1.69	274.2	6.93
18	4,238	550	0	2,766	922	0	0	0	0	0	6.0	2.97	150.0	4.19
19	50,071	9,900	14,728	19,083	6,361	0	0	0	0	0	38.1	1.02	372.3	16.18
20	16,487	4,400	0	9,065	3,022	0	0	0	0	0	83.0	13.03	173.3	7.00
21	18,302	3,300	0	11,252	3,751	0	0	0	0	0	100.0	6.63	90.1	13.10
22	11,626	2,750	0	6,657	2,219	0	0	0	0	0	67.4	9.03	94.0	0.94
23	13,330	2,750	0	7,935	2,645	0	0	0	0	0	87.9	2.84	96.0	1.54
24	22,668	4,400	6,814	8,591	2,864	0	0	0	0	0	67.9	1.48	224.5	5.88
25	50,906	9,900	9,922	23,313	7,771	0	0	0	0	0	65.0	1.30	337.3	7.26
26	4,126	0	1,627	1,874	625	0	0	0	0	0	14.2	0.50	167.9	1.84
27	72,225	15,400	22,529	25,722	8,574	0	0	0	0	0	15.0	1.98	619.0	7.48
28	69,312	14,300	0	41,259	13,753	0	0	0	0	0	92.1	21.58	0.0	0.00
29	211,550	6,600	4,790	0	0	0	0	200,160	0	0	21.0	1.51	584.9	56.45

REVISED

Basin Outflow Pipe, Orifice Plate, Inlet Control



Basin #1

P101 **Outflow Pipe**

Flow Characteristics

Pipe Dia. (inch)	12		
D (inch)	11.00	→	Orifice diameter
A_o (s.f.)	0.66	→	Area of orifice
g (f/s^2)	32.2	→	Acceleration due to gravity
H (ft)	4.00	→	Head at Inlet
h_o (ft)	3.54	→	Head at center of orifice
C_d	0.61	→	Discharge coefficient for sharp edged orifice plate

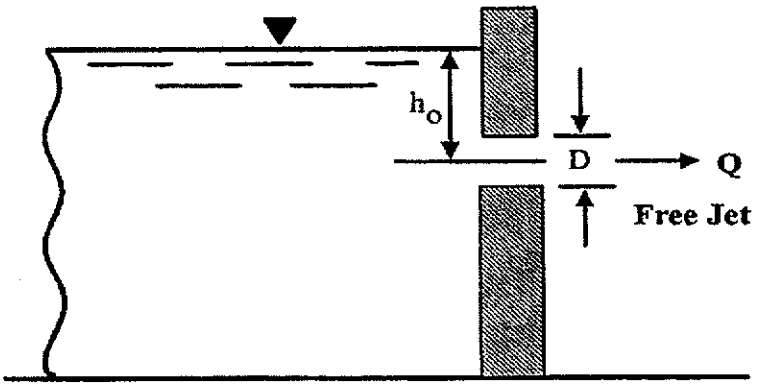
Equation 6.3.2 in HERPICC Stormwater Drainage Manual - Revised July 1994

$$Q = C_d * A_o \sqrt{2 * g * h_o}$$

Q = 6.08 cfs

REVISED

Basin Outflow Pipe, Orifice Plate, Inlet Control



Basin #1

P101 **Outflow Pipe**

Flow Characteristics

Pipe Dia. (inch)	12		
D (inch)	11.00	→	Orifice diameter
A_o (s.f.)	0.66	→	Area of orifice
g (f/s^2)	32.2	→	Acceleration due to gravity
H (ft)	4.50	→	Head at Inlet
h_o (ft)	4.04	→	Head at center of orifice
C_d	0.61	→	Discharge coefficient for sharp edged orifice plate

Equation 6.3.2 in HERPICC Stormwater Drainage Manual - Revised July 1994

$$Q = C_d * A_o \sqrt{2 * g * h_o}$$

100 year flow rate **Q = 6.49 cfs**

REVISED

VANDERBURGH COUNTY DRAINAGE BOARD
FORM 800

PROJECT: **Enclave at Eagle Cliff Subdivision Basin #1 - Final**
DETENTION FACILITY DESIGN RETURN PERIOD: 25 YRS
DESIGNER: Morley and Assoc. BSH

WATERSHED AREA (A):	4.94	ACRES
DEVELOPED RUNOFF COEFFICIENT (Cd):	0.60	
ALLOWABLE RELEASE RATE [OUTLET CONTROL] (O):	6.08	CFS

STORM DURATION Td (HRS)	RAINFALL INTENSITY Id (INCH/HR)	INFLOW RATE I(Td) (Cd*Id*A) (CFS)	OUTFLOW RATE O (CFS)	STORAGE RATE I(Td)-O (CFS)	REQUIRED STORAGE (I(Td)-O)*Td/12 (ACRE-FT)
0.08	7.208	21.36	6.08	15.28	0.106
0.17	5.925	17.56	6.08	11.48	0.159
0.25	5.033	14.92	6.08	8.84	0.184
0.33	4.571	13.55	6.08	7.47	0.207
0.42	4.108	12.18	6.08	6.10	0.212
0.50	3.646	10.81	6.08	4.73	0.197
0.58	3.385	10.03	6.08	3.95	0.192
0.67	3.123	9.26	6.08	3.18	0.177
0.75	2.862	8.48	6.08	2.40	0.150
0.83	2.601	7.71	6.08	1.63	0.113
0.92	2.339	6.93	6.08	0.85	0.065
1.00	2.078	6.16	6.08	0.08	0.007
1.25	1.909	5.66	6.08	-0.42	-0.044
1.50	1.739	5.15	6.08	-0.93	-0.116
1.75	1.570	4.65	6.08	-1.43	-0.208
2.00	1.400	4.15	6.08	-1.93	-0.322
2.50	1.210	3.58	6.08	-2.50	-0.520
3.00	1.019	3.02	6.08	-3.06	-0.765
4.00	0.836	2.48	6.08	-3.60	-1.201
5.00	0.684	2.03	6.08	-4.05	-1.689
6.00	0.589	1.75	6.08	-4.33	-2.167
7.00	0.516	1.53	6.08	-4.55	-2.655
8.00	0.463	1.37	6.08	-4.71	-3.138
9.00	0.415	1.23	6.08	-4.85	-3.637
10.00	0.379	1.12	6.08	-4.96	-4.131

PEAK STORAGE (ACRE/FT):	0.21
PEAK STORAGE (CUBIC FT):	9,222

Storage Volume:

As-built storage volume of Basin #1 is 16,761 Cubic Feet, therefore the basin has sufficient capactiy as constructed.

Cut/Fill Report

Generated: 2014-10-02 11:23:29

By user: morley

Drawing: J:\8000s\8600-8699\8699\Civil\Civil 3D\J:\8000s\8600-8699\8699\Civil\Civil 3D\8699 Base.dwg

As-built Basin #1 Storage Volume

Volume Summary							
Name	**Type**	**Cut Factor**	**Fill Factor**	**2d Area** (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
basin 1 storage volume	full	1.000	1.000	29471.87	620.79	2958.43	2337.63<Fill>

Totals				
	2d Area (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Total	29471.87	620.79	2958.43	2337.63<Fill>

* Value adjusted by cut or fill factor other than 1.0

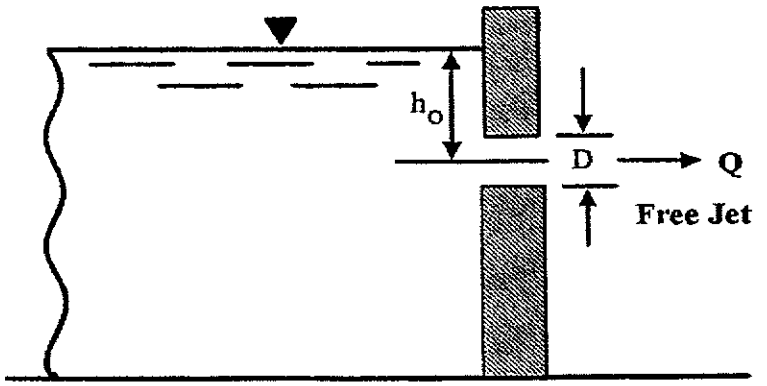
Storage Volume of Basin #1 under the Emergency Overflow elevation Per As-built survey data.

(620.79) * 27 = 16761.33 cubic Feet

As-built survey date: 6-5-14

REVISED

Basin Outflow Pipe, Orifice Plate, Inlet Control



Basin #2

P131 **Outflow Pipe**

Flow Characteristics

Pipe Dia. (inch)	18		
D (inch)	16.00	→	Orifice diameter
A_o (s.f.)	1.40	→	Area of orifice
g (f/s^2)	32.2	→	Acceleration due to gravity
H (ft)	3.88	→	Head at Inlet
h_o (ft)	3.21	→	Head at center of orifice
C_d	0.61	→	Discharge coefficient for sharp edged orifice plate

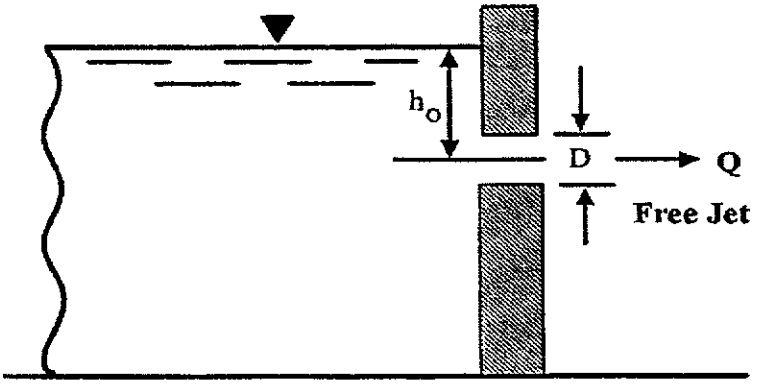
Equation 6.3.2 in HERPICC Stormwater Drainage Manual - Revised July 1994

$$Q = C_d * A_o \sqrt{2 * g * h_o}$$

Q = 12.25 cfs

REVISED

Basin Outflow Pipe, Orifice Plate, Inlet Control



Basin #2

P131 **Outflow Pipe**

Flow Characteristics

Pipe Dia. (inch)	18		
D (inch)	16.00	→	Orifice diameter
A_o (s.f.)	1.40	→	Area of orifice
g (f/s^2)	32.2	→	Acceleration due to gravity
H (ft)	4.50	→	Head at Inlet
h_o (ft)	3.83	→	Head at center of orifice
C_d	0.61	→	Discharge coefficient for sharp edged orifice plate

Equation 6.3.2 in HERPICC Stormwater Drainage Manual - Revised July 1994

$$Q = C_d * A_o \sqrt{2 * g * h_o}$$

100 year flow rate **Q = 13.38 cfs**

VANDERBURGH COUNTY DRAINAGE BOARD
FORM 800

PROJECT: **Enclave at Eagle Cliff Subdivision Basin #2 - Final REVISED**
DETENTION FACILITY DESIGN RETURN PERIOD: 25 YRS
DESIGNER: Morley and Assoc. BSH

WATERSHED AREA (A):	9.36	ACRES
DEVELOPED RUNOFF COEFFICIENT (Cd):	0.48	
ALLOWABLE RELEASE RATE [OUTLET CONTROL] (O):	12.25	CFS

STORM DURATION Td (HRS)	RAINFALL INTENSITY Id (INCH/HR)	INFLOW RATE I(Td) (Cd*Id*A) (CFS)	OUTFLOW RATE O (CFS)	STORAGE RATE I(Td)-O (CFS)	0.800 REQUIRED STORAGE I(Td)-O)*Td/12 (ACRE-FT)
0.08	7.208	32.38	12.25	20.13	0.140
0.17	5.925	26.62	12.25	14.37	0.200
0.25	5.033	22.61	12.25	10.36	0.216
0.33	4.571	20.54	12.25	8.29	0.230
0.42	4.108	18.46	12.25	6.21	0.216
0.50	3.646	16.38	12.25	4.13	0.172
0.58	3.385	15.21	12.25	2.96	0.144
0.67	3.123	14.03	12.25	1.78	0.099
0.75	2.862	12.86	12.25	0.61	0.038
0.83	2.601	11.68	12.25	-0.57	-0.039
0.92	2.339	10.51	12.25	-1.74	-0.133
1.00	2.078	9.34	12.25	-2.91	-0.243
1.25	1.909	8.57	12.25	-3.68	-0.383
1.50	1.739	7.81	12.25	-4.44	-0.555
1.75	1.570	7.05	12.25	-5.20	-0.758
2.00	1.400	6.29	12.25	-5.96	-0.993
2.50	1.210	5.43	12.25	-6.82	-1.420
3.00	1.019	4.58	12.25	-7.67	-1.918
4.00	0.836	3.76	12.25	-8.49	-2.831

PEAK STORAGE (ACRE/FT):	0.23
PEAK STORAGE (CUBIC FT):	10,025

Asbuilt Storage Volume:

Incremental Depth (ft)	Total Volume (cf)	Storage Elevation	
0	0	483.00	Asbuilt Elevation of outflow FES 130
1	1,197	484.00	
2	3,589	485.00	
3	7,010	486.00	
3.45	8,896	486.45	Asbuilt Top of Bank (no emergency overflow constructed yet)
4	11,526	487.00	Assuming berm/emergency overflow is constructed to design elevation with existing constructed basin and 4:1 slopes for additional berm height required.

RECEIVED BY EMAIL
10/14/2014 10AM

VANDERBURGH COUNTY DRAINAGE BOARD
FORM 800

PROJECT: **Enclave at Eagle Cliff Subdivision Basin #1 - Final**
DETENTION FACILITY DESIGN RETURN PERIOD: 25 YRS
DESIGNER: Morley and Assoc. BSH

WATERSHED AREA (A):	4.94	ACRES
DEVELOPED RUNOFF COEFFICIENT (Cd):	0.60	
ALLOWABLE RELEASE RATE [OUTLET CONTROL] (O):	6.08	CFS

STORM DURATION Td (HRS)	RAINFALL INTENSITY Id (INCH/HR)	INFLOW RATE I(Td) (Cd*Id*A) (CFS)	OUTFLOW RATE O (CFS)	STORAGE RATE I(Td)-O (CFS)	REQUIRED STORAGE (I(Td)-O)*Td/12 (ACRE-FT)
0.08	7.208	21.36	6.08	15.28	0.106
0.17	5.925	17.56	6.08	11.48	0.159
0.25	5.033	14.92	6.08	8.84	0.184
0.33	4.571	13.55	6.08	7.47	0.207
0.42	4.108	12.18	6.08	6.10	0.212
0.50	3.646	10.81	6.08	4.73	0.197
0.58	3.385	10.03	6.08	3.95	0.192
0.67	3.123	9.26	6.08	3.18	0.177
0.75	2.862	8.48	6.08	2.40	0.150
0.83	2.601	7.71	6.08	1.63	0.113
0.92	2.339	6.93	6.08	0.85	0.065
1.00	2.078	6.16	6.08	0.08	0.007
1.25	1.909	5.66	6.08	-0.42	-0.044
1.50	1.739	5.15	6.08	-0.93	-0.116
1.75	1.570	4.65	6.08	-1.43	-0.208
2.00	1.400	4.15	6.08	-1.93	-0.322
2.50	1.210	3.58	6.08	-2.50	-0.520
3.00	1.019	3.02	6.08	-3.06	-0.765
4.00	0.836	2.48	6.08	-3.60	-1.201
5.00	0.684	2.03	6.08	-4.05	-1.689
6.00	0.589	1.75	6.08	-4.33	-2.167
7.00	0.516	1.53	6.08	-4.55	-2.655
8.00	0.463	1.37	6.08	-4.71	-3.138
9.00	0.415	1.23	6.08	-4.85	-3.637
10.00	0.379	1.12	6.08	-4.96	-4.131

PEAK STORAGE (ACRE/FT):	0.21
PEAK STORAGE (CUBIC FT):	9,222

Asbuilt Storage Volume:

Incremental Depth (ft)	Total Volume (cf)	Storage Elevation	
0	0	483.00	Asbuilt Elevation of outflow FES 100
1	280	484.00	
2	2,491	485.00	
3	6,553	486.00	
3.52	9,438	486.45	Asbuilt Emergency Overflow elevation

RECEIVED BY EMAIL
10/14/2014 JDM

REVISED

VANDERBURGH COUNTY DRAINAGE BOARD
FORM 800

PROJECT: **Enclave at Eagle Cliff Subdivision Basin #2 - Final REVISED**
DETENTION FACILITY DESIGN RETURN PERIOD: 25 YRS
DESIGNER: Morley and Assoc. BSH

WATERSHED AREA (A):	9.36	ACRES
DEVELOPED RUNOFF COEFFICIENT (Cd):	0.48	
ALLOWABLE RELEASE RATE [OUTLET CONTROL] (O):	12.25	CFS

STORM DURATION Td (HRS)	RAINFALL INTENSITY Id (INCH/HR)	INFLOW RATE I(Td) (Cd*Id*A) (CFS)	OUTFLOW RATE O (CFS)	STORAGE RATE I(Td)-O (CFS)	0.800 REQUIRED STORAGE I(Td)-O)*Td/12 (ACRE-FT)
0.08	7.208	32.38	12.25	20.13	0.140
0.17	5.925	26.62	12.25	14.37	0.200
0.25	5.033	22.61	12.25	10.36	0.216
0.33	4.571	20.54	12.25	8.29	0.230
0.42	4.108	18.46	12.25	6.21	0.216
0.50	3.646	16.38	12.25	4.13	0.172
0.58	3.385	15.21	12.25	2.96	0.144
0.67	3.123	14.03	12.25	1.78	0.099
0.75	2.862	12.86	12.25	0.61	0.038
0.83	2.601	11.68	12.25	-0.57	-0.039
0.92	2.339	10.51	12.25	-1.74	-0.133
1.00	2.078	9.34	12.25	-2.91	-0.243
1.25	1.909	8.57	12.25	-3.68	-0.383
1.50	1.739	7.81	12.25	-4.44	-0.555
1.75	1.570	7.05	12.25	-5.20	-0.758
2.00	1.400	6.29	12.25	-5.96	-0.993
2.50	1.210	5.43	12.25	-6.82	-1.420
3.00	1.019	4.58	12.25	-7.67	-1.918
4.00	0.836	3.76	12.25	-8.49	-2.831

PEAK STORAGE (ACRE/FT):	0.23
PEAK STORAGE (CUBIC FT):	10,025

Storage Volume:

Incremental Depth (ft)	Incremental Area (sf)	Incremental Volume (cf)	Total Volume (cf)
0	0	0	0
1	1735.14	868	868
2	2731.49	2,233	3,101
3	3828.36	3,280	6,381
3.88	4876.76	3,830	10,211
4	5025.76	594	10,805

Cut/Fill Report

Generated: 2014-10-07 10:32:54

By user: morley

Drawing: J:\8000s\8600-8699\8699\Civil\Civil 3D\J:\8000s\8600-8699\8699\Civil\Civil 3D\8699 Base.dwg

As-built Basin #2 Storage Volume

Volume Summary							
Name	**Type**	**Cut Factor**	**Fill Factor**	**2d Area** (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Basin 2 storage volume Asbuilt	full	1.000	1.000	9844.80	329.49	651.34	321.85<Fill>

Totals				
	2d Area (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Total	9844.80	329.49	651.34	321.85<Fill>

* Value adjusted by cut or fill factor other than 1.0

Storage Volume of Basin #2 under the Top of Bank elevation as built per Survey data.

(329.49) x 27 = 8896.23 cubic feet

As-built survey date: 6-5-14

As-built TOB is 486.45 at lowest point. Design TOB is 488.00. If basin TOB is Raised, Volume of Basin is Sufficient.

(426.05) x 27 = 11,503 cubic feet (under emergency overflow elev. of 487.00)

Required Storage = 10,025 CF

Pre-Developed Drainage Subbasins

Subbasin	Area (ac.)	Weighted C	I(100) (in/hr)	Q(100) (CFS)
1	0.33	0.80	8.47	2.24
2	1.88	0.80	7.38	11.09
3	1.26	0.80	7.37	7.45
4	0.61	0.80	7.73	3.79
5	0.45	0.36	7.07	1.13
6	0.19	0.61	7.37	0.84
7	1.46	0.50	6.71	4.93
8	0.36	0.42	6.88	1.02
9.1	0.27	0.47	8.36	1.05
9.2	0.13	0.47	8.47	0.53
10	1.01	0.55	8.47	4.71
11	0.00	0.92	8.47	0.03
12	0.05	0.21	8.47	0.09
13	0.19	0.59	7.32	0.84
14	0.67	0.37	7.46	1.86
15	0.21	0.35	6.84	0.51
16	0.25	0.32	7.19	0.59
17	0.79	0.53	7.07	2.94
18	0.10	0.27	8.47	0.22
19	1.15	0.54	7.70	4.79
20	0.38	0.37	7.59	1.07
21	0.42	0.31	6.91	0.90
22	0.27	0.35	7.66	0.72
23	0.31	0.33	6.66	0.67
24	0.52	0.54	7.07	2.00
25	1.17	0.47	6.83	3.71
26	0.09	0.47	8.40	0.37
27	1.66	0.57	8.28	7.78
28	1.59	0.33	7.71	4.03
29	4.86	0.50	8.26	20.21

Basin #2, typical

Basin #1, typical

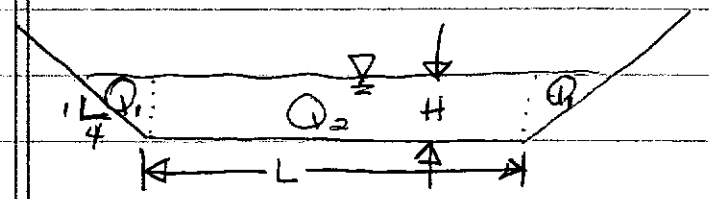
Basin #1 100 year
Flow total = 22.31 CFS

Basin #2 100 year
Flow total = 37.68 CFS

REVISED

BROAD CRESTED WEIR FLOW — REVISED
BASIN EMERGENCY OVERFLOW

BASIN #1 $Q^{100}_{required} = 22.31\ CFS - 6.49\ CFS$
$= 15.82\ CFS$



$Q = C_d L H^{3/2}$
$C_d = 2.7$ weir coefficient

$Q_T = 2Q_1 + Q_2 = 2\left(2.7(H(4))\left(\frac{H}{2}\right)^{3/2}\right) + 2.7 L H^{3/2}$

if $H = 0.5'$, $L = 10'$, $Q = ?$
$Q_T = 2\left(2.7(0.5)(4)\left(\frac{0.5}{2}\right)^{3/2}\right) + 2.7(10)(0.5)^{3/2}$
$Q_T = 10.91\ CFS$

if $H = 0.5'$, $Q = 15.82\ CFS$, $L = ?$
$15.82 = 2\left(2.7(0.5)(4)\left(\frac{0.5}{2}\right)^{3/2}\right) + 2.7(L)(0.5)^{3/2}$
$L = \frac{15.82 - 2\left(2.7(0.5)(4)\left(\frac{0.5}{2}\right)^{3/2}\right)}{2.7(0.5)^{3/2}} = \frac{14.44}{0.95}$
$L = 15.16'$

use 15.2' wide EO for Basin #1

Basin #2 $Q^{100}_{required} = 37.68\ CFS - 13.38\ CFS$
$= 24.3\ CFS$

if $H = 0.5'$, $Q = 24.3\ CFS$, $L = ?$
$24.3 = 2\left(2.7(0.5)(4)\left(\frac{0.5}{2}\right)^{3/2}\right) + 2.7L(0.5)^{3/2}$
$L = \frac{24.3 - 2\left(2.7(0.5)(4)\left(\frac{0.5}{2}\right)^{3/2}\right)}{2.7(0.5)^{3/2}} = \frac{22.95}{0.95}$
$L = 24.16'$ use 24.2' wide EO for Basin #2

Structure Report

Struct No.	Structure ID	Junction Type	Rim Elev (ft)	Structure			Line Out			Line In		
				Shape	Length (ft)	Width (ft)	Size (in)	Shape	Invert (ft)	Size (in)	Shape	Invert (ft)
1	FES 133	OpenHeadwall	504.71	n/a	n/a	n/a	12	Cir	503.48			
2	CI 124	DropCurb	499.97	Rect	2.00	3.00	15	Cir	497.42	15	Cir	497.45
3	CI 122	DropCurb	499.97	Rect	2.00	3.00	15	Cir	497.68			
4	CI 107	DropCurb	497.97	Rect	2.00	3.00	15	Cir	490.36	12	Cir	494.33
5	CI 105	DropCurb	497.97	Rect	2.00	3.00	12	Cir	495.00			
6	CI 114	DropCurb	496.82	Rect	2.00	3.00	24	Cir	493.38	24	Cir	493.38
7	CI 112	DropCurb	496.82	Rect	2.00	3.00	24	Cir	493.51	24	Cir	493.53
8	FES 110	OpenHeadwall	496.47	n/a	n/a	n/a	24	Cir	494.16			
9	MH 127B	Manhole	491.29	Cir	4.00	4.00	18	Cir	484.27	15	Cir	486.96
10	CI 127	DropCurb	492.32	Rect	2.00	3.00	15	Cir	488.07			
11	MH 119B	Manhole	490.38	Cir	4.00	4.00	24	Cir	484.29	24	Cir	485.24
12	CI 119	DropCurb	489.89	Rect	3.00	3.00	24	Cir	485.88	24	Cir	485.90
13	FES 117	OpenHeadwall	490.40	n/a	n/a	n/a	24	Cir	488.09			
14	MH 138	DropCurb	486.58	Rect	2.00	3.00	24	Cir	482.11	24	Cir	482.41
15	Null Structure	None	0.00	n/a	n/a	n/a	24	Cir	482.53			
16	FES 100	OpenHeadwall	482.22	n/a	n/a	n/a	12	Cir	480.99			
17	FES 102	OpenHeadwall	481.33	n/a	n/a	n/a	18	Cir	479.48			
18	FES 130	OpenHeadwall	484.21	n/a	n/a	n/a	18	Cir	482.49			

Storm Sewer Summary Report

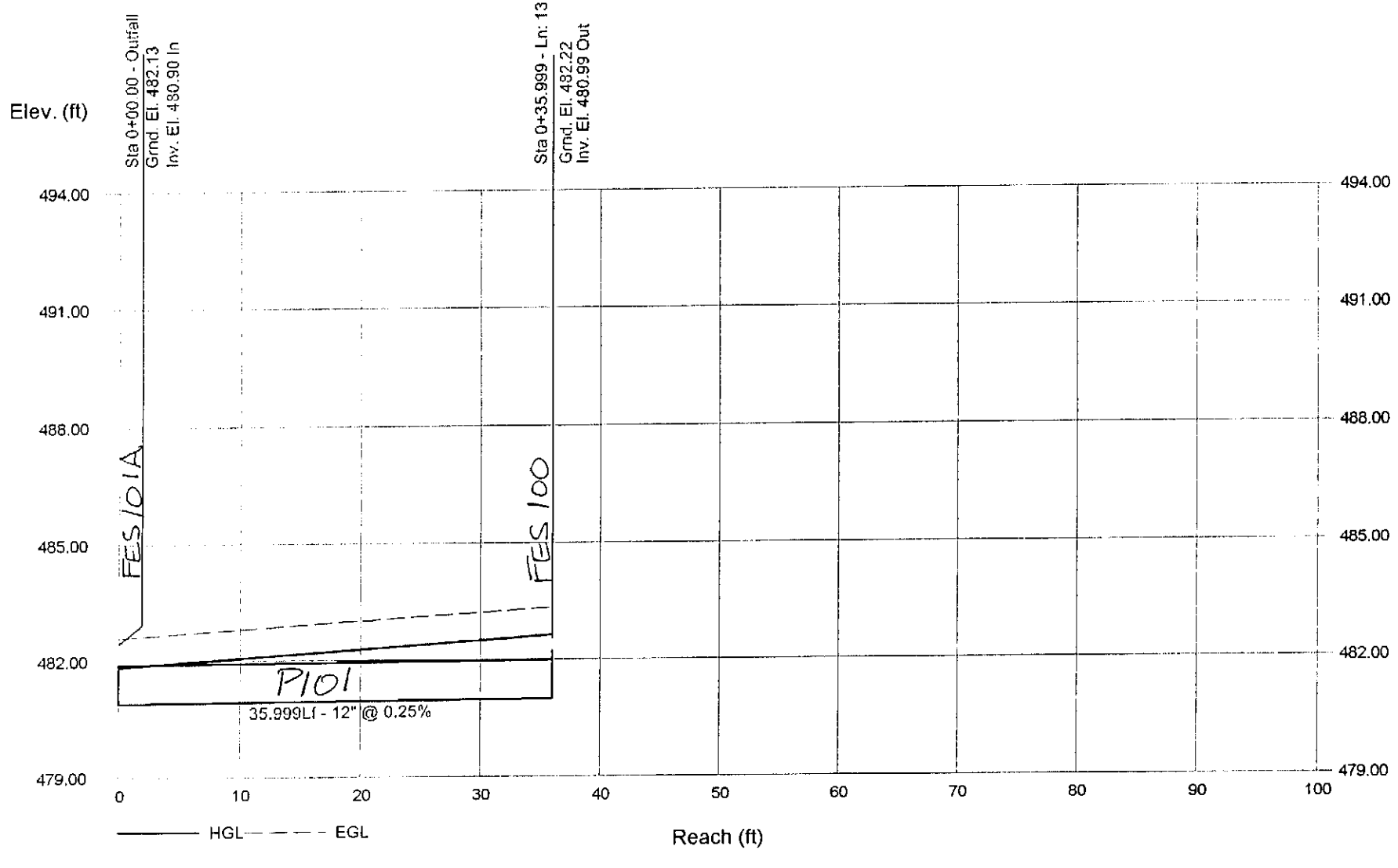
Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	P 134	0.34	12	Cir	114.062	502.20	503.48	1.122	502.40	503.72	n/a	503.72	End	OpenHeadwall
2	P 125	5.58	15	Cir	133.816	496.06	497.42	1.016	496.95	498.38	0.24	498.38	End	DropCurb
3	P 123	3.74	15	Cir	27.500	497.45	497.68	0.836	498.38	498.46	n/a	498.46 j	2	DropCurb
4	P 108	11.58	15	Cir	120.667	486.20	490.36	3.447	487.19	491.57	n/a	491.57	End	DropCurb
5	P 106	5.21	12	Cir	27.000	494.33	495.00	2.482	495.09	495.93	n/a	495.93	4	DropCurb
6	P 115	11.77	24	Cir	30.730	493.30	493.38	0.260	494.53	494.84	0.18	495.02	End	DropCurb
7	P 113	11.52	24	Cir	27.000	493.38	493.51	0.481	495.02	495.06	0.15	495.21	6	DropCurb
8	P 111	10.75	24	Cir	30.730	493.53	494.16	2.050	495.21	495.33	n/a	495.33 j	7	OpenHeadwall
9	P 128	7.80	18	Cir	136.941	483.15	484.27	0.818	484.19	485.35	0.48	485.35	End	Manhole
10	P 127A	7.80	15	Cir	64.352	486.96	488.07	1.725	487.91	489.17	n/a	489.17	9	DropCurb
11	P 120	20.96	24	Cir	136.378	483.15	484.29	0.836	484.79	485.98	0.81	486.79	End	Manhole
12	P 119A	17.28	24	Cir	63.715	485.24	485.88	1.004	486.79	487.38	n/a	487.38 j	11	DropCurb
13	P 118	13.55	24	Cir	44.348	485.90	488.09	4.938	487.38	489.41	n/a	489.41 j	12	OpenHeadwall
14	P 139	14.54	24	Cir	22.788	482.02	482.11	0.395	483.39	483.65	0.24	483.90	End	DropCurb
15	P 137	8.31	24	Cir	60.038	482.41	482.53	0.200	483.90	483.99	0.18	484.17	14	None
16	P 101	5.32	12	Cir	35.999	480.90	480.99	0.250	481.83*	482.63*	0.71	483.34	End	OpenHeadwall
17	P 103	6.80	18	Cir	105.839	478.90	479.48	0.548	479.86	480.49	0.45	480.49	End	OpenHeadwall
18	P 131	12.49	18	Cir	96.000	474.01	482.49	8.833	474.67	483.82	0.88	483.82	End	OpenHeadwall

Project File: Revised System 5-15-14.stm | Number of lines: 18 | Run Date: 5/15/2014

NOTES: Return period = 25 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Profile

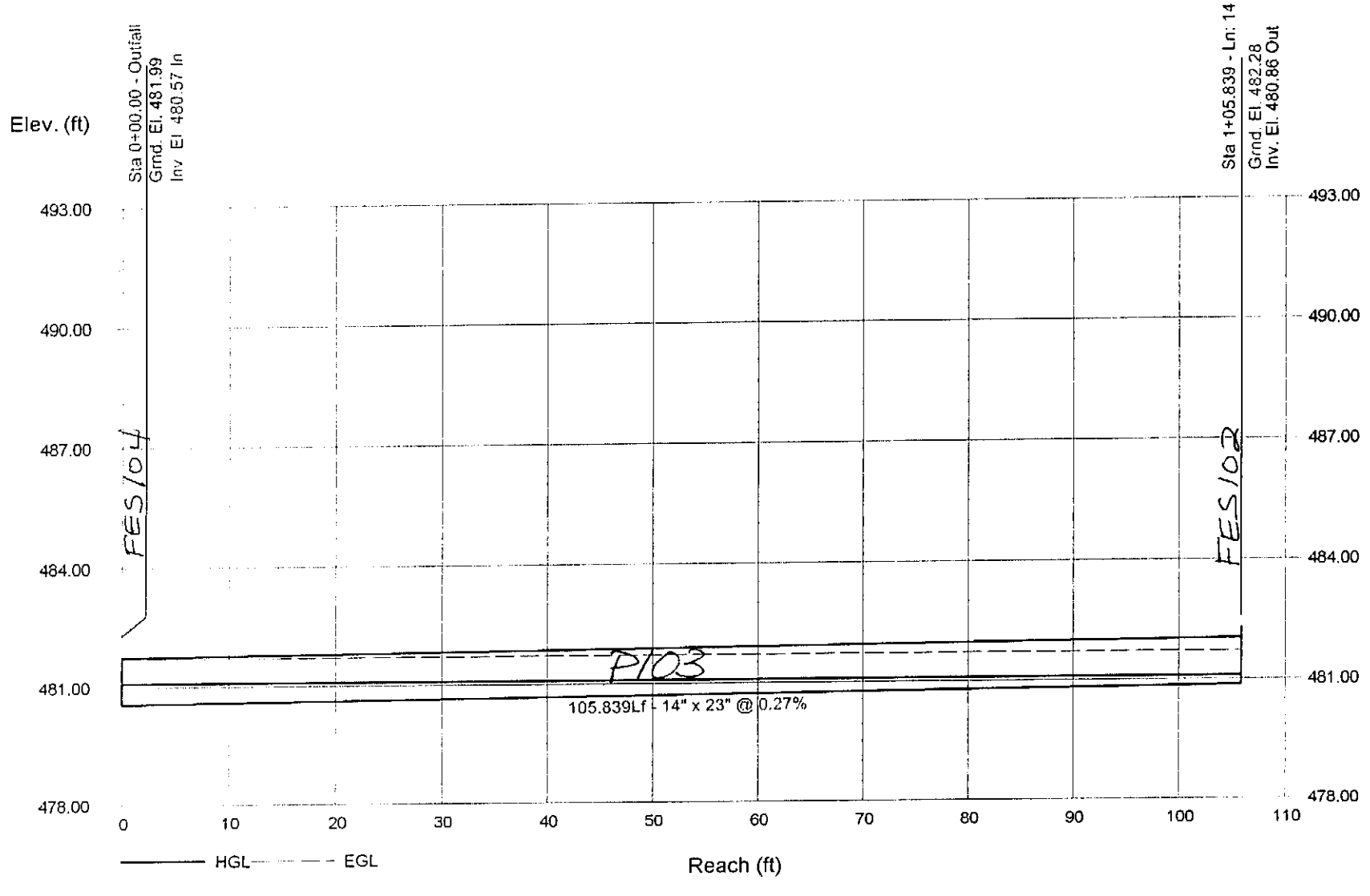
Proj. file: Total Project 6-19-13.stm



Drains Basin #1 to Felstead Road Ditch

Storm Sewer Profile

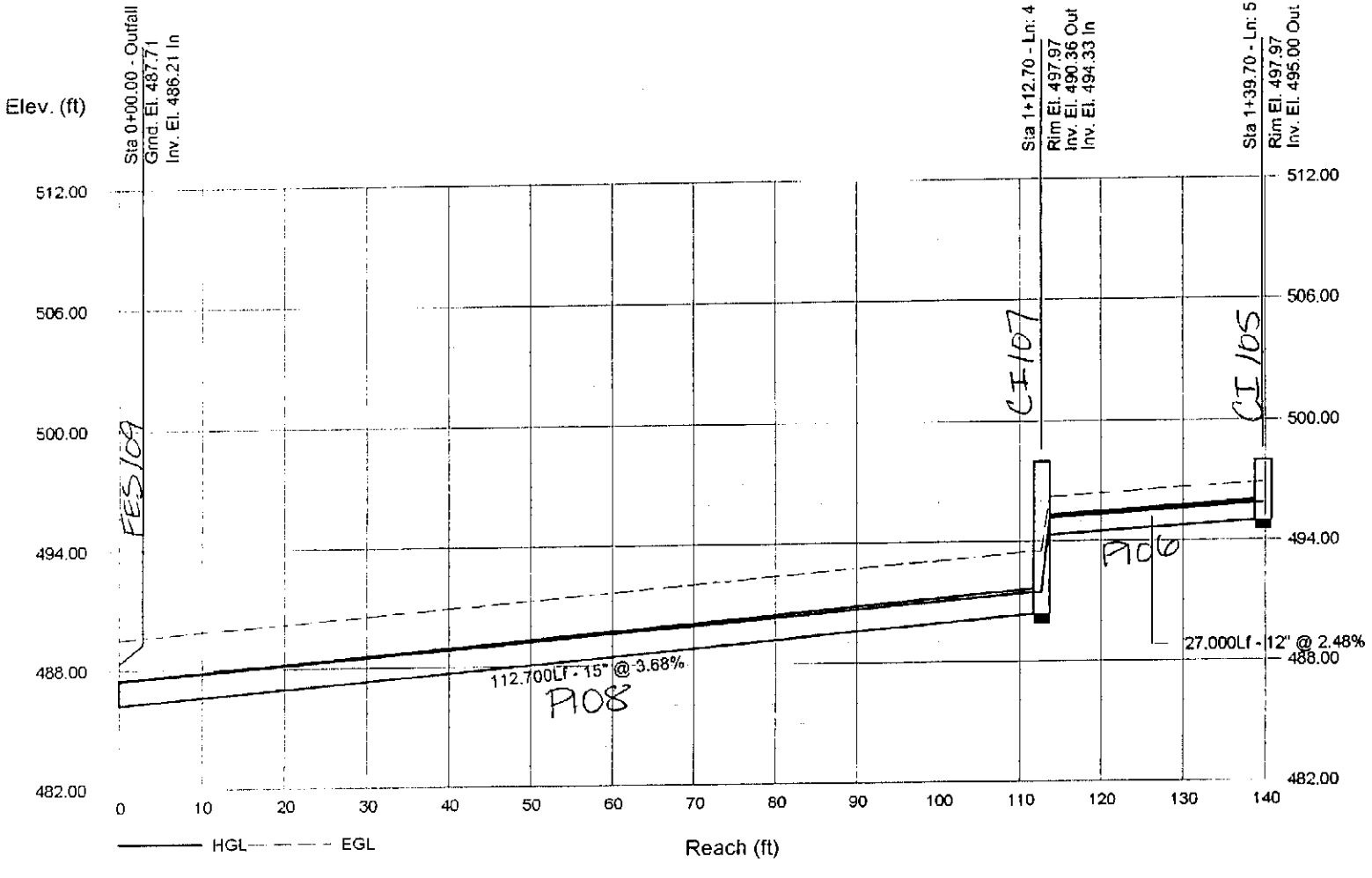
Proj. file: Total Project 6-19-13.stm



Felstead Road Ditch near Basin #1

Storm Sewer Profile

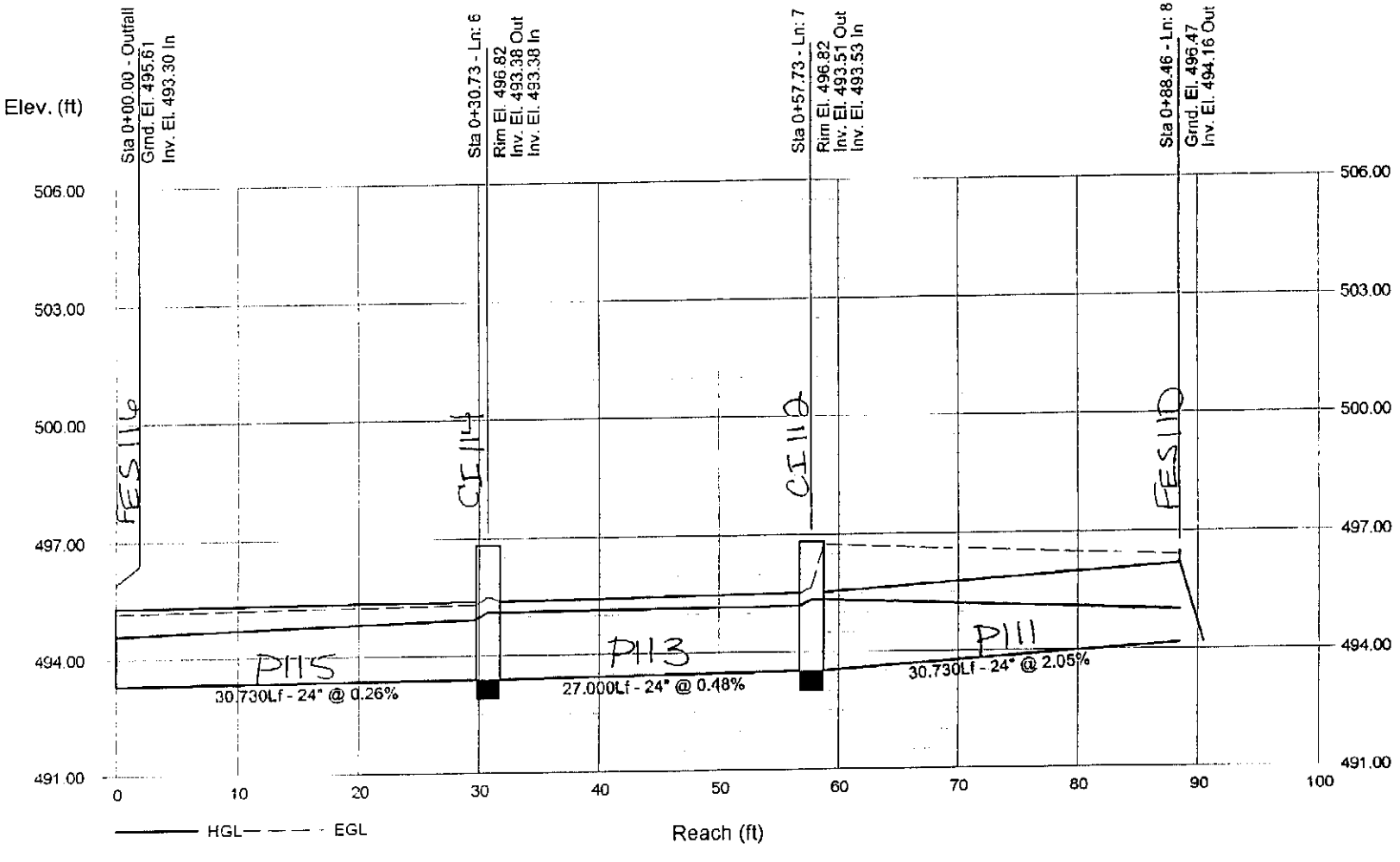
Proj. file: Total Project 5-15-13.stm



Drains Steller Drive to Basin #1

Storm Sewer Profile

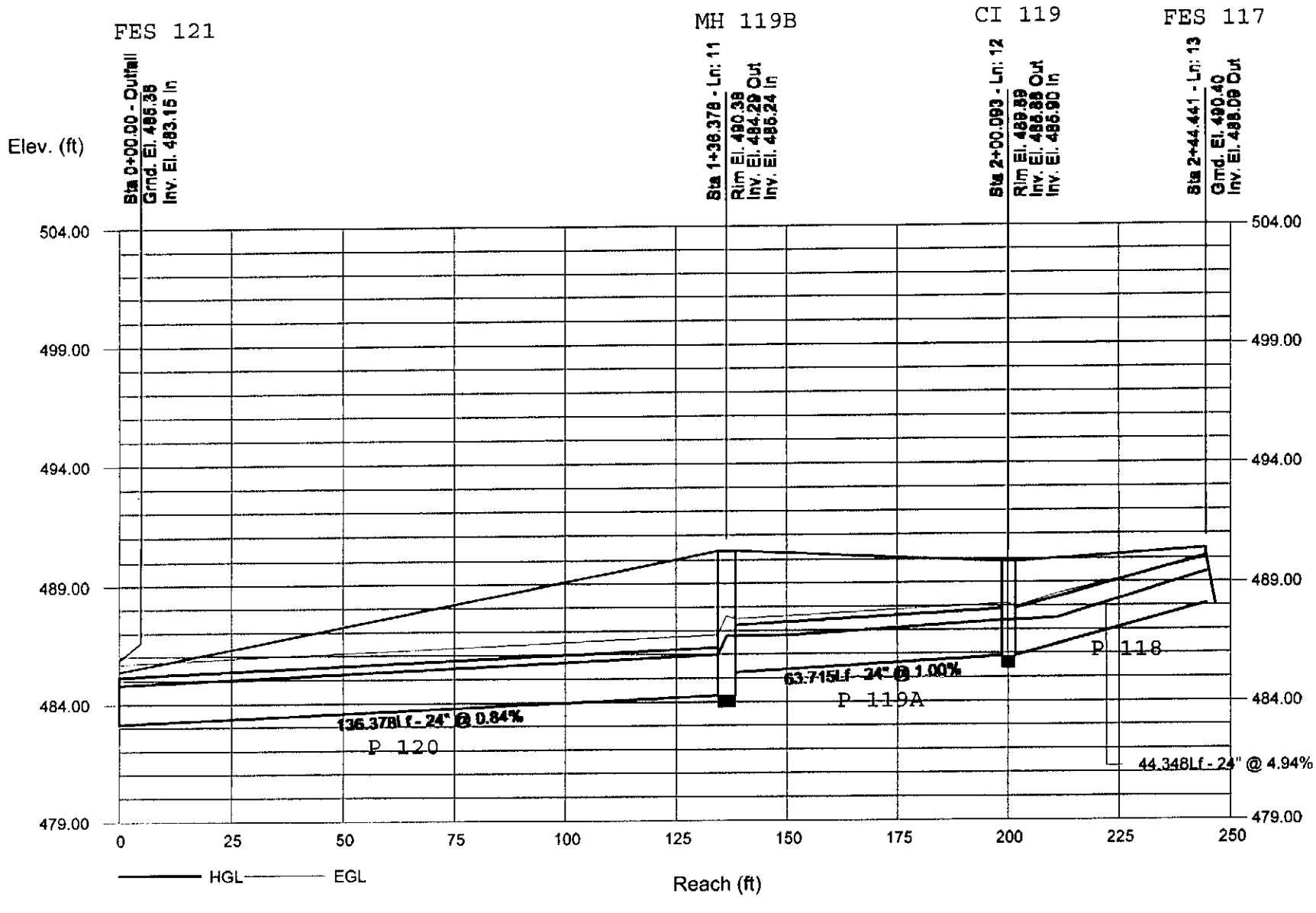
Proj. file: Total Project 5-15-13.stm



Drains Steller Drive to Swale 203 along West Pl

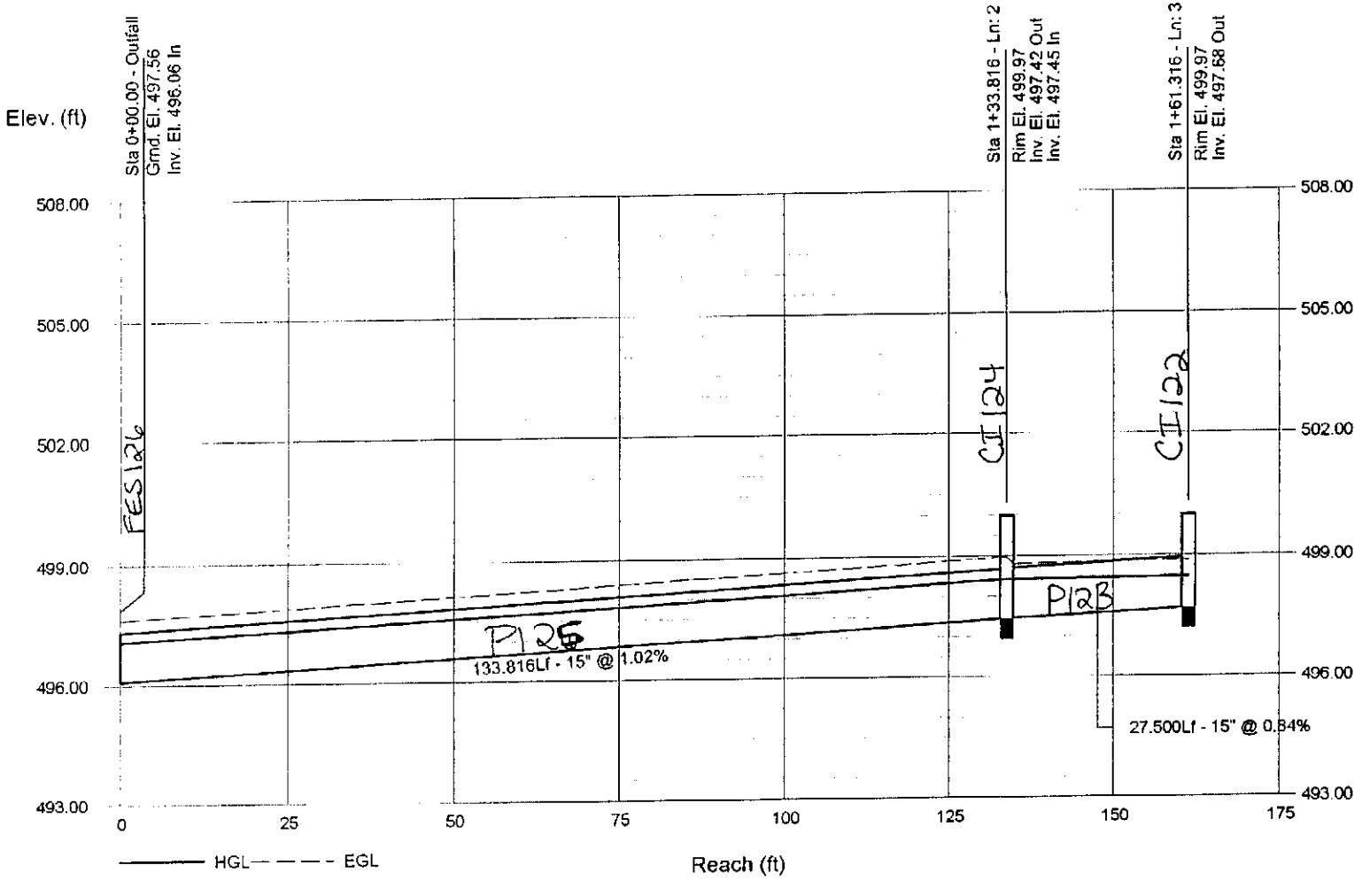
Storm Sewer Profile

Proj. file: Revised System 5-15-14.stm



Storm Sewer Profile

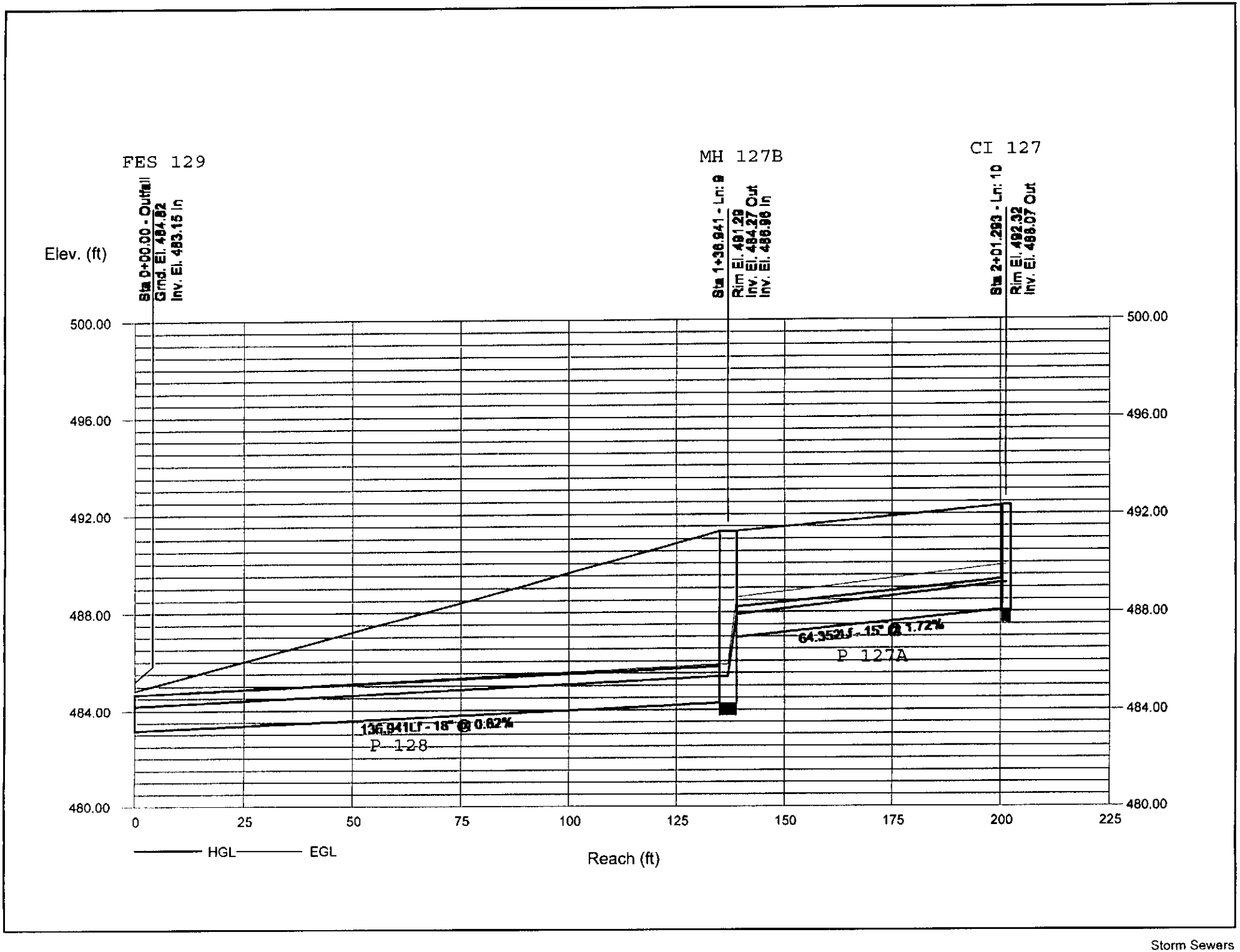
Proj. file: Total Project 5-15-13.stm



Drains Road #1 to Rear Yard Swales

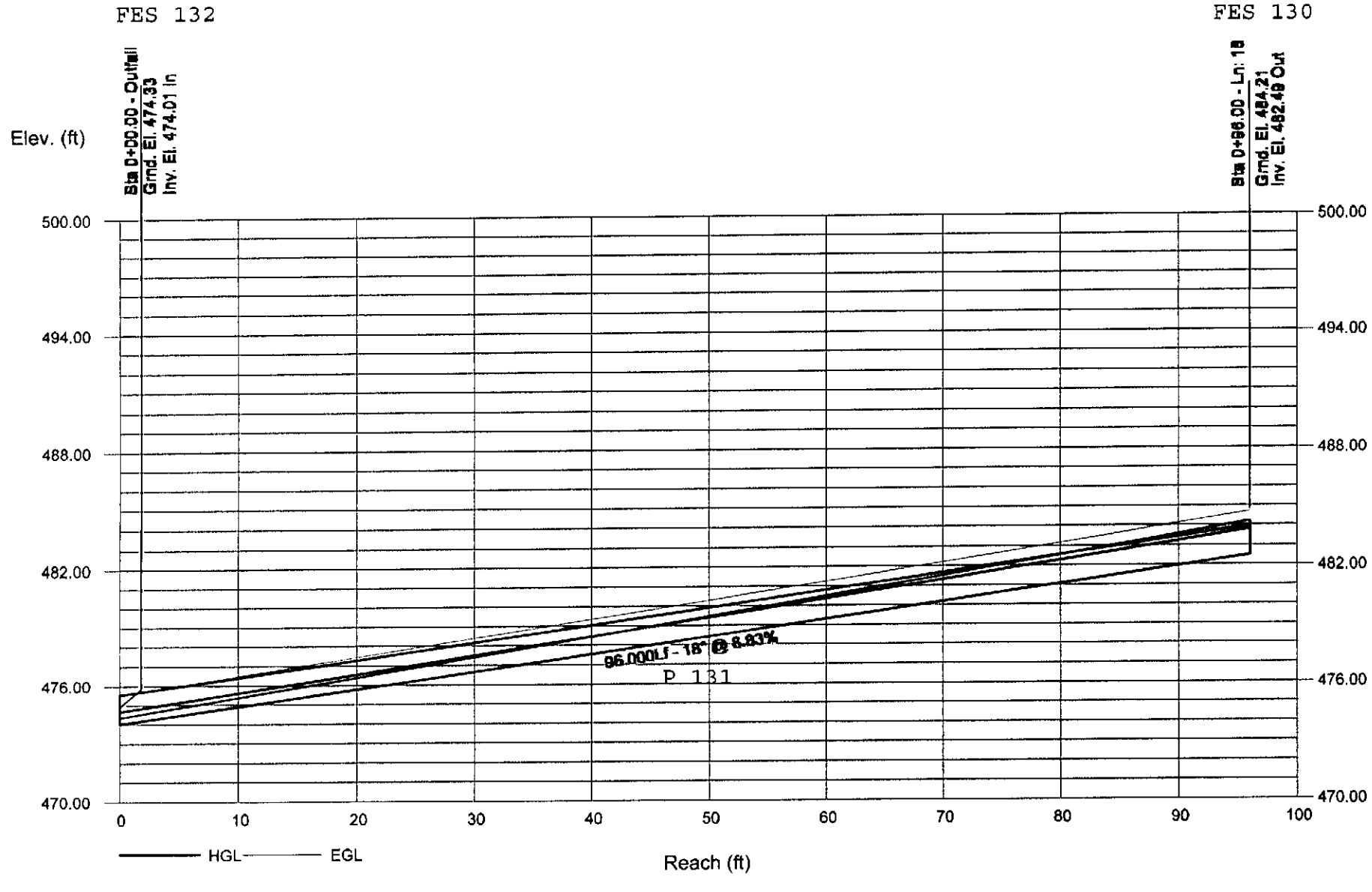
Storm Sewer Profile

Proj. file: Revised System 5-15-14.stm



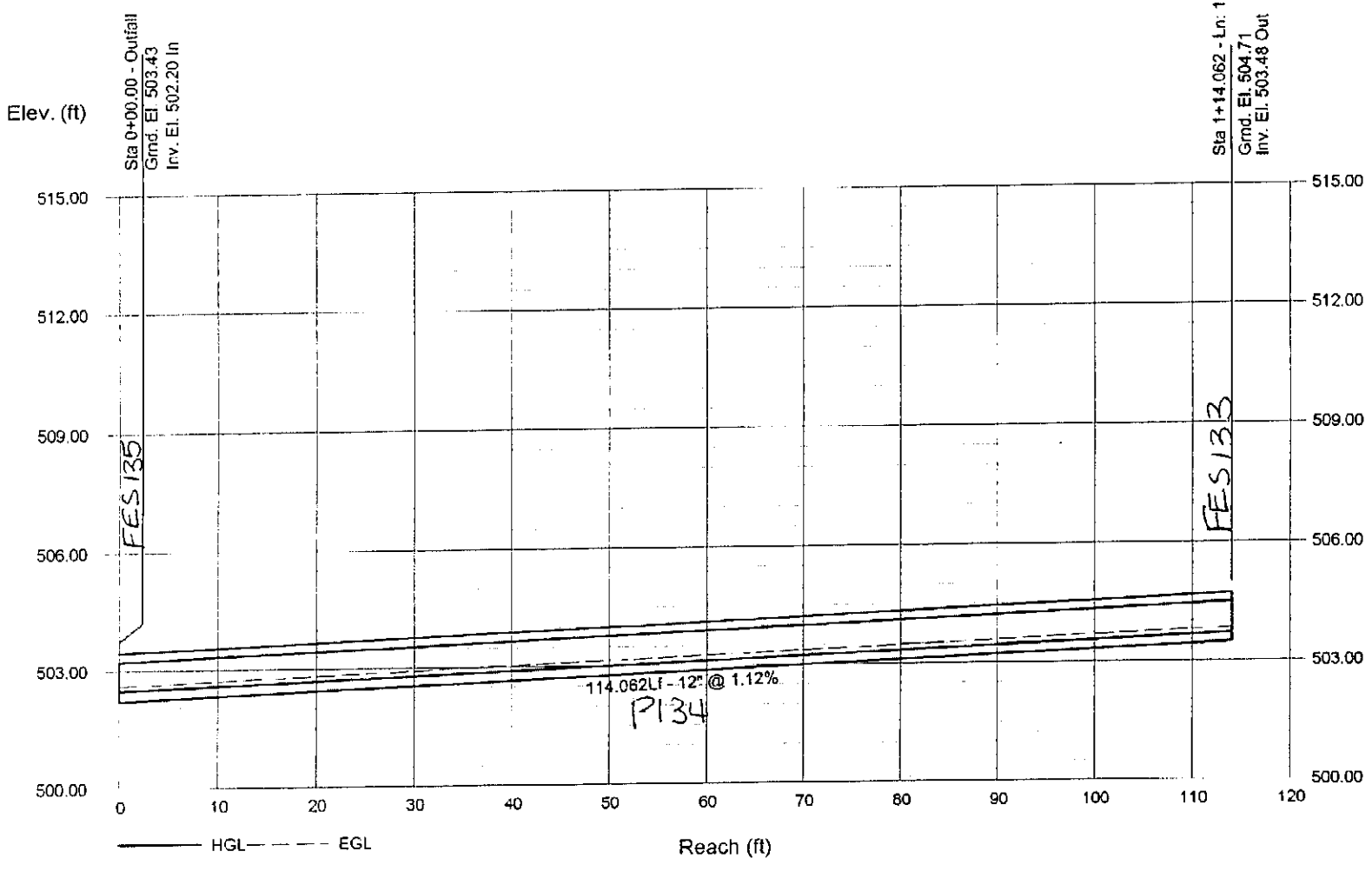
Storm Sewer Profile

Proj. file: Revised System 5-15-14.stm



Storm Sewer Profile

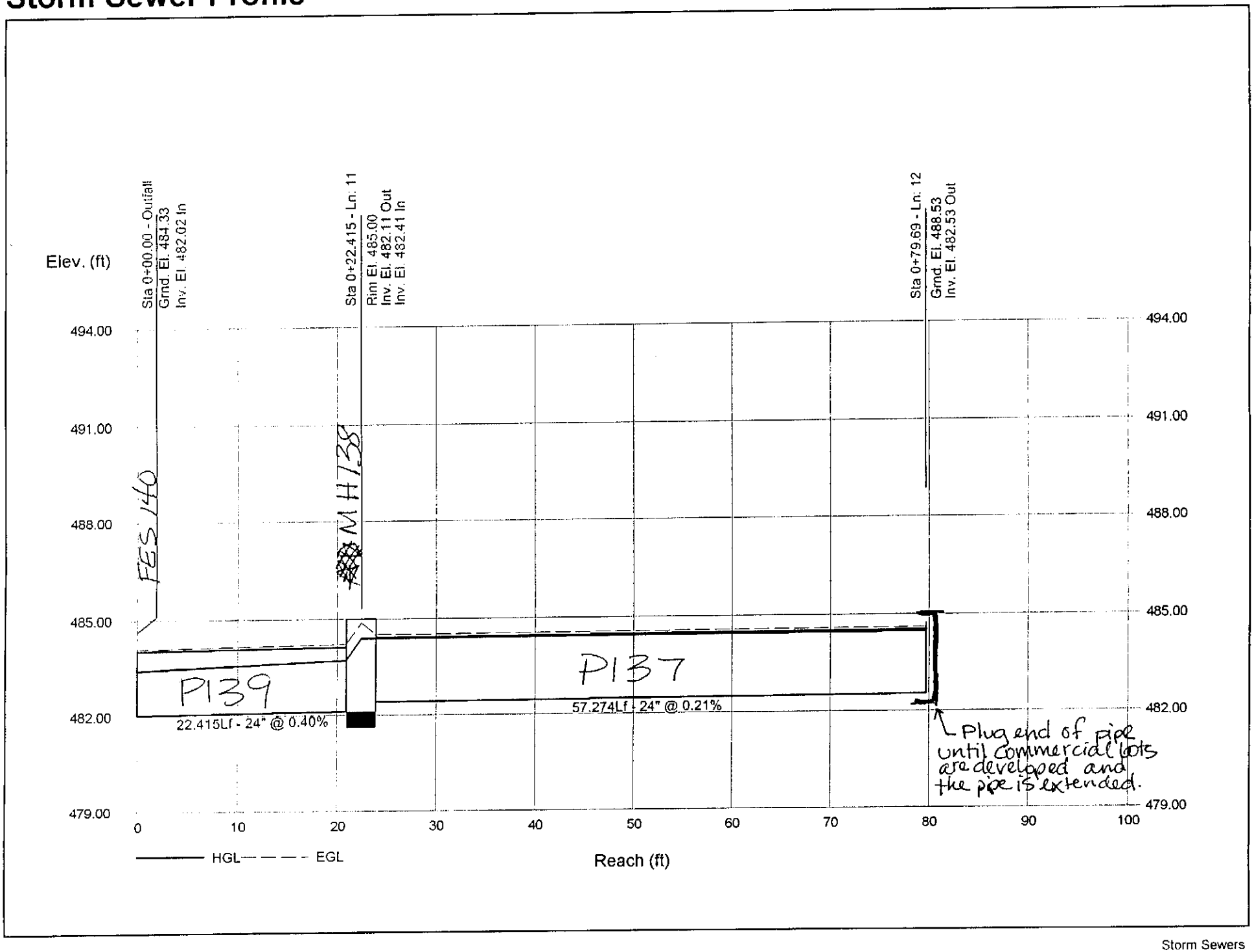
Proj. file: Total Project 5-15-13.stm



Drains Felstead Road Ditch under Cliftwood Drive

Storm Sewer Profile

Proj. file: Total Project 6-19-13.stm



Morley and Associates, Inc.
Engineering . Surveying . Architecture . Construction Management
4800 Rosebud Lane
Newburgh, IN 47630
Phone (812) 464-9585 * Fax (812) 464-2514
www.morleyandassociates.com
e-mail: info@morleyandassociates.com

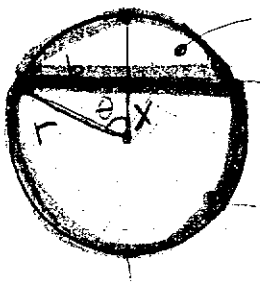
Project NEW PAGE

Project No. **Sheet** **of**

Date **By**

What is flow velocity of P131 out of basin?

P131 = 18" RCP r = radius = 9" = 0.75'



$V = Q/A_f$

Q = [illegible]

flow rate from basin [illegible]

A_f = [illegible]

$A_f = \pi(r)^2 - A_o$

$A_o = \left[\frac{2\theta}{360}\pi(r)^2\right] - 2\left[\frac{1}{2}bx\right]$

↑ area of sector of circle ↑ area of [illegible]

$x = (HGL - IE) - r = (479.25 - 478.25) - 0.75' = 0.25'$

$\cos\theta = \frac{x}{r}$ $\theta = \cos^{-1}\left(\frac{x}{r}\right) = \cos^{-1}\left(\frac{0.25}{0.75}\right) = 70.53°$

$\sin\theta = \frac{b}{r}$ $b = r\sin\theta = 0.75\sin 70.53 = 0.71'$

$A_f = \pi(0.75)^2 - \left(\left[\frac{2(70.53)}{360}\pi(0.75)^2\right] - 2\left[\frac{1}{2}(0.71)(0.25)\right]\right)$

$A_f = 1.77 - (0.672 - 0.178)$

$A_f = 1.25$ [illegible]

$V = Q/A_f = \frac{12.25\ cfs}{1.25\ sf} =$ 9.75 fps < [illegible]

∴ P131 flow velocity [illegible]

REVISED

Open Channel Flow

S200

Side slope =	0.33		
Bottom width =	2	Flow through Swale =	3.53 cfs
Manning's coefficient =	0.035		
Slope of channel =	0.0719		

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.58	2.53	1.33
0.2	2.42	0.52	0.21	0.24	2.13	4.09	1.46
0.3	2.63	0.87	0.33	0.40	4.75	5.46	1.53
0.4	2.84	1.28	0.45	0.57	8.58	6.71	1.57
0.5	3.05	1.75	0.57	0.75	13.78	7.88	1.60
0.6	3.26	2.28	0.70	0.95	20.49	8.99	1.62
0.7	3.47	2.87	0.83	1.17	28.84	10.05	1.64
0.8	3.68	3.52	0.96	1.39	38.97	11.07	1.65
0.9	3.90	4.23	1.09	1.63	51.01	12.06	1.66
1	4.11	5.00	1.22	1.88	65.08	13.02	1.67

Open Channel Flow

S201

Side slope =	0.33		
Bottom width =	2	Flow through Swale =	1.74 cfs
Manning's coefficient =	0.035		
Slope of channel =	0.0494		

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.48	2.09	1.11
0.2	2.42	0.52	0.21	0.24	1.76	3.39	1.21
0.3	2.63	0.87	0.33	0.40	3.94	4.52	1.27
0.4	2.84	1.28	0.45	0.57	7.12	5.56	1.30
0.5	3.05	1.75	0.57	0.75	11.43	6.53	1.33
0.6	3.26	2.28	0.70	0.95	16.99	7.45	1.35
0.7	3.47	2.87	0.83	1.17	23.91	8.33	1.36
0.8	3.68	3.52	0.96	1.39	32.31	9.18	1.37
0.9	3.90	4.23	1.09	1.63	42.28	10.00	1.38
1	4.11	5.00	1.22	1.88	53.95	10.79	1.39

Open Channel Flow

S202

Side slope =	0.25		
Bottom width =	1.0	Flow through Swale =	0.45 cfs
Manning's coefficient =	0.035		
Slope of channel =	0.0528		

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	1.21	0.13	0.11	0.12	0.29	2.22	1.11
0.2	1.41	0.32	0.23	0.29	1.16	3.64	1.19
0.3	1.62	0.57	0.35	0.50	2.78	4.88	1.22
0.4	1.82	0.88	0.48	0.73	5.29	6.02	1.24
0.5	2.03	1.25	0.62	1.00	8.85	7.08	1.25
0.6	2.24	1.68	0.75	1.29	13.58	8.08	1.25
0.7	2.44	2.17	0.89	1.61	19.61	9.04	1.26
0.8	2.65	2.72	1.03	1.94	27.08	9.96	1.26
0.9	2.86	3.33	1.17	2.30	36.09	10.84	1.26
1	3.06	4.00	1.31	2.67	46.76	11.69	1.26

Open Channel Flow

S203

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.008

Flow through Swale = 11.86 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.19	0.84	0.44
0.2	2.42	0.52	0.21	0.24	0.71	1.37	0.49
0.3	2.63	0.87	0.33	0.40	1.58	1.82	0.51
0.4	2.84	1.28	0.45	0.57	2.86	2.24	0.52
0.5	3.05	1.75	0.57	0.75	4.60	2.63	0.53
0.6	3.26	2.28	0.70	0.95	6.84	3.00	0.54
0.7	3.47	2.87	0.83	1.17	9.62	3.35	0.55
0.8	3.68	3.52	0.96	1.39	13.00	3.69	0.55
0.9	3.90	4.23	1.09	1.63	17.02	4.02	0.56
1	4.11	5.00	1.22	1.88	21.71	4.34	0.56

Open Channel Flow

S204

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.0544

Flow through Swale = 0.48 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.51	2.20	1.16
0.2	2.42	0.52	0.21	0.24	1.85	3.56	1.27
0.3	2.63	0.87	0.33	0.40	4.13	4.75	1.33
0.4	2.84	1.28	0.45	0.57	7.47	5.83	1.37
0.5	3.05	1.75	0.57	0.75	11.99	6.85	1.39
0.6	3.26	2.28	0.70	0.95	17.82	7.82	1.41
0.7	3.47	2.87	0.83	1.17	25.09	8.74	1.43
0.8	3.68	3.52	0.96	1.39	33.90	9.63	1.44
0.9	3.90	4.23	1.09	1.63	44.37	10.49	1.45
1	4.11	5.00	1.22	1.88	56.61	11.32	1.46

Open Channel Flow

S205

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.0081

Flow through Swale = 0.55 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.19	0.85	0.45
0.2	2.42	0.52	0.21	0.24	0.71	1.37	0.49
0.3	2.63	0.87	0.33	0.40	1.59	1.83	0.51
0.4	2.84	1.28	0.45	0.57	2.88	2.25	0.53
0.5	3.05	1.75	0.57	0.75	4.63	2.64	0.54
0.6	3.26	2.28	0.70	0.95	6.88	3.02	0.54
0.7	3.47	2.87	0.83	1.17	9.68	3.37	0.55
0.8	3.68	3.52	0.96	1.39	13.08	3.72	0.56
0.9	3.90	4.23	1.09	1.63	17.12	4.05	0.56
1	4.11	5.00	1.22	1.88	21.85	4.37	0.56

Open Channel Flow

S206

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.0113

Flow through Swale = 2.57 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.23	1.00	0.53
0.2	2.42	0.52	0.21	0.24	0.84	1.62	0.58
0.3	2.63	0.87	0.33	0.40	1.88	2.16	0.61
0.4	2.84	1.28	0.45	0.57	3.40	2.66	0.62
0.5	3.05	1.75	0.57	0.75	5.46	3.12	0.63
0.6	3.26	2.28	0.70	0.95	8.12	3.56	0.64
0.7	3.47	2.87	0.83	1.17	11.43	3.98	0.65
0.8	3.68	3.52	0.96	1.39	15.45	4.39	0.66
0.9	3.90	4.23	1.09	1.63	20.22	4.78	0.66
1	4.11	5.00	1.22	1.88	25.80	5.16	0.66

Open Channel Flow

S207A

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.008

Flow through Swale = 13.78 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.19	0.84	0.44
0.2	2.42	0.52	0.21	0.24	0.71	1.37	0.49
0.3	2.63	0.87	0.33	0.40	1.58	1.82	0.51
0.4	2.84	1.28	0.45	0.57	2.86	2.24	0.52
0.5	3.05	1.75	0.57	0.75	4.60	2.63	0.53
0.6	3.26	2.28	0.70	0.95	6.84	3.00	0.54
0.7	3.47	2.87	0.83	1.17	9.62	3.35	0.55
0.8	3.68	3.52	0.96	1.39	13.00	3.69	0.55
0.9	3.90	4.23	1.09	1.63	17.02	4.02	0.56
1	4.11	5.00	1.22	1.88	21.71	4.34	0.56

Open Channel Flow

S207B

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.0568

Flow through Swale = 13.78 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.52	2.24	1.19
0.2	2.42	0.52	0.21	0.24	1.89	3.64	1.30
0.3	2.63	0.87	0.33	0.40	4.22	4.85	1.36
0.4	2.84	1.28	0.45	0.57	7.63	5.96	1.40
0.5	3.05	1.75	0.57	0.75	12.25	7.00	1.42
0.6	3.26	2.28	0.70	0.95	18.21	7.99	1.44
0.7	3.47	2.87	0.83	1.17	25.64	8.93	1.46
0.8	3.68	3.52	0.96	1.39	34.64	9.84	1.47
0.9	3.90	4.23	1.09	1.63	45.34	10.72	1.48
1	4.11	5.00	1.22	1.88	57.85	11.57	1.49

Open Channel Flow

S208

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.0365

Flow through Swale = 0.67 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.41	1.80	0.95
0.2	2.42	0.52	0.21	0.24	1.52	2.92	1.04
0.3	2.63	0.87	0.33	0.40	3.38	3.89	1.09
0.4	2.84	1.28	0.45	0.57	6.12	4.78	1.12
0.5	3.05	1.75	0.57	0.75	9.82	5.61	1.14
0.6	3.26	2.28	0.70	0.95	14.60	6.40	1.16
0.7	3.47	2.87	0.83	1.17	20.55	7.16	1.17
0.8	3.68	3.52	0.96	1.39	27.77	7.89	1.18
0.9	3.90	4.23	1.09	1.63	36.35	8.59	1.19
1	4.11	5.00	1.22	1.88	46.37	9.27	1.19

Open Channel Flow

S209

Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.01

Flow through Swale = 5.71 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.22	0.94	0.50
0.2	2.42	0.52	0.21	0.24	0.79	1.53	0.54
0.3	2.63	0.87	0.33	0.40	1.77	2.04	0.57
0.4	2.84	1.28	0.45	0.57	3.20	2.50	0.59
0.5	3.05	1.75	0.57	0.75	5.14	2.94	0.60
0.6	3.26	2.28	0.70	0.95	7.64	3.35	0.61
0.7	3.47	2.87	0.83	1.17	10.76	3.75	0.61
0.8	3.68	3.52	0.96	1.39	14.53	4.13	0.62
0.9	3.90	4.23	1.09	1.63	19.02	4.50	0.62
1	4.11	5.00	1.22	1.88	24.27	4.85	0.62

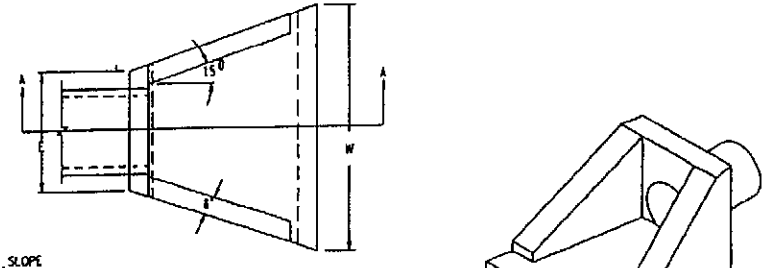
Open Channel Flow

S210

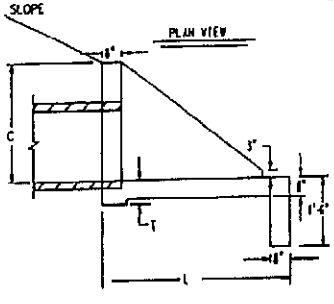
Side slope = 0.33
Bottom width = 2
Manning's coefficient = 0.035
Slope of channel = 0.1166

Flow through Swale = 7.09 cfs

Depth (ft)	Wetted Perimeter (ft)	Area (ft^2)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flowrate (cfs)	Velocity (ft/s)	F value
0.1	2.21	0.23	0.10	0.11	0.74	3.22	1.70
0.2	2.42	0.52	0.21	0.24	2.71	5.21	1.86
0.3	2.63	0.87	0.33	0.40	6.05	6.95	1.95
0.4	2.84	1.28	0.45	0.57	10.93	8.54	2.00
0.5	3.05	1.75	0.57	0.75	17.55	10.03	2.04
0.6	3.26	2.28	0.70	0.95	26.09	11.45	2.07
0.7	3.47	2.87	0.83	1.17	36.73	12.80	2.09
0.8	3.68	3.52	0.96	1.39	49.63	14.10	2.11
0.9	3.90	4.23	1.09	1.63	64.96	15.36	2.12
1	4.11	5.00	1.22	1.88	82.88	16.58	2.13



ISOMETRIC VIEW



SECTION A-A

T ≤ PIPE WALL THICKNESS+1-1/2"

DIMENSIONS					
PIPE DIA.	C	L	W	E	WEIGHT
12"& 15"	2'-6"	4'-8"	4'-9"	2'-6"	3,040lbs.
18"	3'-3"	4'-6"	5'-3"	3'-0"	3,766lbs.
24"	3'-9"	5'-6"	6'-0"	3'-6"	5,480lbs.

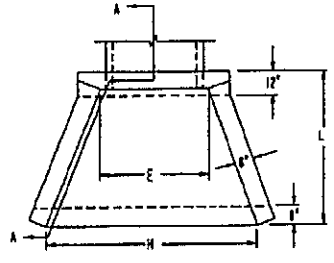
GENERAL NOTES:

1. # 5 REBAR 12" C.C. EA. WAY GRADE 60
2. 3/4" CHAMFER ON ALL EXPOSED EDGES
3. CONCRETE: 4500PSI @ 28 DAYS
4. 2" CONCRETE COVER
5. CONFORMS TO KOCH STD. DRAWING NO. RDH-020-05
6. PIPE OPENING IN FACE OF WALL EQUALS PIPE I.D.

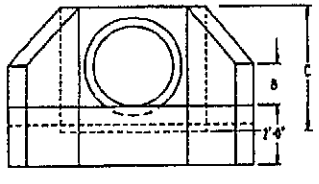
SHERMANDIXIE

PH# 1-800-737-0707 | DWG# ET-236

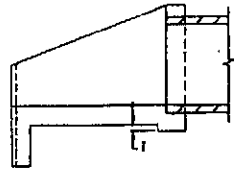
SLOPED & FLARED HEADWALLS 12"- 24" | SCALE: NTS | DATE:09/12/08 | SHEET# 1 OF 1



PLAN VIEW



FRONT ELEVATION



SECTION A-A

DIMENSIONS						
PIPE DIA.	C	L	B	E	H	WEIGHT
30"	4'-5"	4'-5"	1'-1"	3'-1"	1'-5"	6,800lbs.
36"	5'-0"	5'-0"	1'-1"	3'-1"	1'-6"	8,700lbs.
42"	5'-1"	5'-1"	1'-3"	4'-3"	10'-8"	10,850lbs.
48"	6'-2½"	6'-2"	2'-0"	4'-10"	11'-0"	13,233lbs.
54"	6'-10"	6'-5"	2'-3"	5'-5"	12'-6"	15,835lbs.
60"	7'-3½"	7'-1"	2'-6"	6'-6"	13'-8"	18,670lbs.

GENERAL NOTES:

1. CONCRETE 4500 PSI @ 28 DAYS
2. 2" CONCRETE COVER
3. REINF. # 5 REBAR 12" C.C. EA. WAY GRADE 60
4. 3/4" CHAMFER ON ALL EXPOSED EDGES
5. PIPE OPENING IN FACE OF WALL WILL EQUAL PIPE I.D. FOR 30"- 36" DIA PIPE
6. HOLE SIZE FOR 42"- 60" DIA PIPE = PIPE O.D. + 3"

SHERMANDIXIE

PH# 1-800-737-0707 | DWG# ET-238

PIPE CULVERT HEADWALLS 30"- 60" PIPES 0° SKEW | SCALE: NTS | DATE:09/12/08 | SHEET# 1 OF 1

FELSTEAD ROAD - ROAD SIDE DITCH DS OF P103

SWALE CAPACITY $\Rightarrow$ $Q = \left(\frac{1.49}{n}\right)(A)(HR)^{3/2}(S)^{1/2}$

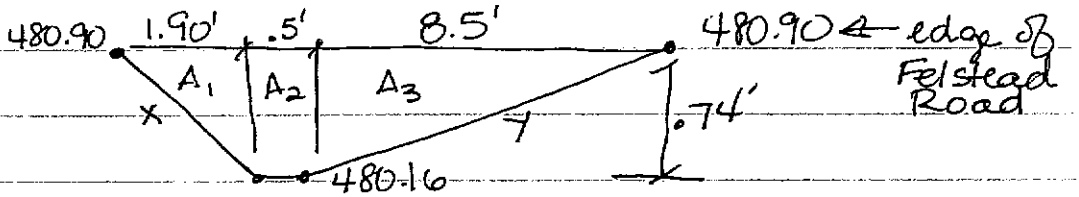
n = Manning Coefficient = 0.035

A = Area

HR = Hydraulic Radius = $\frac{A}{WP} = \frac{\text{Area}}{\text{Wetted Perimeter}}$

S = Slope of Swale = 0.68% = 0.0068

Shallowest point in Roadside Swale:



$A = A_1 + A_2 + A_3 = \frac{1}{2}(.74)(1.90) + .5(.74) + \frac{1}{2}(.74)(8.5)$

$= 4.22$ SF

$WP = x + .5 + y = \sqrt{1.9^2 + .74^2} + .5 + \sqrt{8.5^2 + .74^2} = 11.07$ ft

$HR = \frac{4.22}{11.07} = 0.38$ ft

$Q_{capacity} = \left(\frac{1.49}{0.035}\right)(4.22)(0.38)^{2/3}(0.0068)^{1/2} = 7.77$ CFS

Q_{50} in Roadside swale from P103 = 6.94 CFS

$Q_{capacity} > Q_{50\ required}$ $\therefore$ Swale has capacity

6. Final Drainage Plan