Part III

Nexus Continuum, LLC

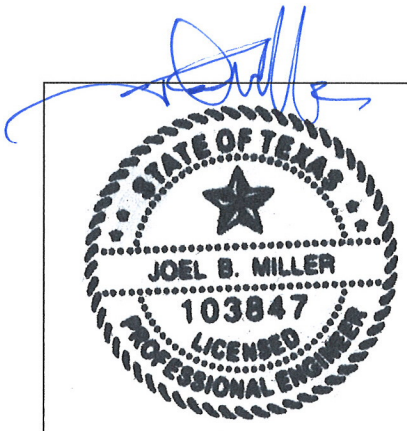
Type V- Municipal Solid Waste Facility

Nexus Material Recovery and Transfer Station

MSW Registration No. XXXXX

Harris County, Texas

October 2011



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Part III
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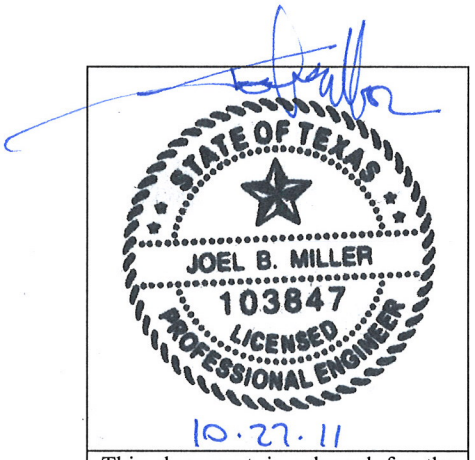

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1.0 SITE DEVELOPMENT PLAN

30 TAC §330.63(a)

In accordance with 30 TAC 330.63(a), the Site Development Plan (SDP) includes criteria used in the selection and design of the facility that provides for safeguarding health, welfare, and physical property of individuals and property. The criteria include geology, soil conditions, drainage, land use, zoning, adequacy of access roads, and other considerations specific to the proposed facility.

The site is located in the Texas Coastal Plain, in the mapped outcrop of the Montgomery Formation (Reference: **Sand Resources of the Gulf Coast**, University of Texas, Bureau of Economic Geology, Report of Investigations No. 60, March 1967).

Soils at the facility are mapped in the Gessner loam and Katy fine sandy loam associations. Both Gessner loam and Katy fine sandy loam soils occur on relatively flat areas (0 to 1 percent). Gessner loam consists of very deep, poorly drained, very slowly permeable soils. The Katy fine sandy loam consists of very deep, moderately well drained, moderately slow permeable soils.

The existing drainage pattern onsite is in the south to southeast direction, and the proposed development will not alter the existing drainage pattern or increase storm water runoff from the site. The proposed facility will be constructed, maintained, and operated to manage run-on and runoff during the peak discharge of a 25-year rainfall event.

Land use in the project area is predominantly industrial. The proposed material recovery and transfer station and related operations will occupy approximately five acres. The site is relatively small and is surrounded by trees and brush, which provides a significant buffer for the commercial, industrial and limited residential land uses adjacent to the property. In addition, Nexus owns adjoining property that provides additional buffer to the north and east.

The site is located in north-eastern Harris County and is not zoned. The site is suitable for industrial use. Within approximately one-quarter mile of the site, commercial development includes:

- Drill Bit Industries, Inc.;
- United Galvanizing, Inc.;
- Waggner Machine & Engineering;
- Kinder Morgan Petcoke, LP.; and
- Astro Waste, Inc.

The facility entrance will be on Cunningham Road, which carries relatively minor automobile and truck traffic compared to the Sam Houston Tollway, a major highway that serves the Houston metro area. Access for administrative staff (office) will be available on the east-side of the facility from Thomas Road. Part II, Attachment A provides a copy of the recent TxDOT coordination regarding this site.

Nexus has operated various municipal solid waste (MSW) collection businesses for more than 15 years, serving primarily the City of Houston and surrounding Harris County. The business currently offices at 6124 Cunningham Road, Houston, Texas. The current business operations occupy approximately 0.75 acres on a 2.5-acre property owned by Nexus, which is proposed to become a part of this Registration. The fact that Nexus has operated its business from this location for more than 15 years is a significant factor in the site selection and design of the proposed facility. Nexus's business is a well-established existing land use in this area.

2.0 GENERAL FACILITY DESIGN

30 TAC §330.63(b)

2.1 Facility Access

§330.63(b)(1)

As shown on the Facility Layout (Part III, Figure 1), the current Nexus facility has 165 feet of frontage on Cunningham Road, this Registration application requests only 60 feet of frontage as access to the processing area. Therefore, the majority of the facility boundary adjoins privately owned property and is separated from these properties with a chainlink fence with barbed wire strands across the top. The adjacent properties north and south of the site appear to be used for industrial purposes. In addition, Nexus owns the properties directly to the north (partial), and east (entire) of the Registration boundary as shown on the Facility Layout (Part III Figure 1). There is no access to the adjacent properties afforded to the general public, so there is no potential for members of the general public to gain access to the site from adjacent properties. Nexus personnel will routinely monitor the condition of the property line fences and will make necessary repairs to maintain their integrity.

The main point of access to the site by vehicular traffic is by means of the main entrance proposed on Cunningham Road. A fence with a lockable gate will be installed, and truck traffic will be physically routed from Cunningham Road through the currently existing roof structure for entrance processing. The exterior gate will be closed and locked during non-operating hours, and when it is opened, any person or vehicle entering the site will be within view of Nexus personnel at the check-in facility. Nexus personnel will not allow any unauthorized entry or deposition of unauthorized solid waste or hazardous materials of any kind. A sign, indicating the type of site, the hours and days of operation, and the registration number will be located at the entrance through which wastes are received.

2.2 Waste Movement

§330.63(b)(2)

The amount of waste and recyclable materials, both commingled and source separated, that will be received at the facility is estimated to be a maximum of 5,000 cubic yards per day (CY/d). The site capacity is discussed in more detail in Part II, Section 2.3 and outlined in Part II, Table II-1 (Projected Waste Acceptance). The facility will have the capacity to process and transfer a maximum of 5,000 CY/d of waste and recyclable material, of which a minimum of 500 CY/d (10%) will be recovered and sent for reuse or recycling. Based on an average incoming density of 400 pounds per cubic yard, the anticipated maximum material to be received is expected to be 1,000 tons per day (TPD). The facility proposes to operate up to 24 hours per day seven days per week to provide options for haulers of MSW and recyclable materials when other facilities are closed.

As shown on the Traffic Flow Diagram (Part III Figure 9), incoming material will be brought to the facility by roll-off trucks, front-end loaders and other collection vehicles and off-loaded immediately onto the tipping floor of the material recovery and transfer station. If the containers contain mostly one type of material, they will be unloaded directly to the storage bins or transfer trailers onsite. The amount of time required for unloading will depend on the composition of the load, but the maximum amount of time anticipated for unloading is 9 minutes for an average 40 CY roll-off or collection vehicle (267 CY/hr), which means that the facility will have the ability to unload and process the proposed Registration maximum of 5,000 CY/d (average 267 CY/hr x 20 hours = 5,340 CY/d – greater than 5,000 CY/d). Based on this maximum daily volume, and the ability of Nexus to schedule its own transport drivers, it is not anticipated that excessive queuing of collection vehicles will be required. However, in the event that queuing is necessary, trucks will be able to line up along the 660' site entrance road (capacity for over 24 trucks). It is not anticipated that trucks will need to queue on Cunningham Road.

Once the collection vehicles have unloaded on the tipping floor, the loads will be sorted by hand (with the aid of excavators, backhoes or similar equipment) by sorting personnel. All

unauthorized waste will be returned to the generator. If an item has no economic value as a recyclable commodity or has no practical reuse potential, the material will then become municipal solid waste (MSW), and will be placed in a transfer trailer and hauled to the nearest properly permitted landfill when the transfer trailer reaches capacity. The selectively separated recyclable commodities will be stored and managed temporarily in separate storage bins, roll-off containers or transfer trailers onsite. When a sufficient quantity of a particular commodity has accumulated, it will be hauled to market. Commodities such as paper, metal, wood, glass, concrete, sheetrock, brush, asphalt, corrugated cardboard, carpeting, and white goods are among these commodities; which will account for more than 10% of the incoming waste stream at this facility. The Process Flow Diagram (Part III Figure 2) provides a graphical overview of the proposed process.

Ventilation of the processing building will be accomplished by an opening on the south side for truck access from the access ramp. In addition, the other three sides will have various doors and windows that will remain open during operations as needed. The building will be a commercially produced metal building of the type sometimes referred to as "pre-engineered". Roll-offs, transfer trailers, and other containers will be kept covered to the extent possible to minimize odors and contact with rain. In addition, the site is surrounded by other industrial facilities, including other property owned by Nexus. Prevailing winds at the site are from the southeast (see wind rose – Part II Figure 1), which will direct potential odors into the exterior wall on the north side of the load out area, thereby keeping odor to the interior of the site. As noted previously, Nexus owns the properties directly to the north, west and east of the processing area. All odorous material will be processed quickly on the tipping floor to minimize the amount of time that the odorous material is exposed. The material will be stored onsite for a maximum period of 72 hours in storage bins, roll-offs, or trailers, which will be covered in order to minimize odor. Extremely odorous material will not be accepted for processing.

General Details (Part III Figures 4 and 5) provide detail drawings for various proposed facility features, including: drainage swale, diesel tank and containment, contaminated water tank, and stormwater detention.

General Details (Part III Figure 6) provides cross-section details of the proposed slab and footing, entrance drive, and tipping wall and transfer-trailer load out area.

Containment dikes may be utilized for secondary containment of the diesel fuel tank and the contaminated water storage. These details are shown on General Details (Part III Figure 5).

No sludge, oil or grease will be handled or processed at the facility.

Contaminated water from received waste and from tipping floor washdown will be collected and stored onsite in steel or fiberglass storage tanks with either built-in secondary containment or external containment by means of concrete or a lined dike. The storage tanks will be manufactured for liquid storage and will have a minimum capacity of 5,000 gallons. The tank will be coated per manufacturer instructions as an aid against corrosion. The Facility Layout (Part III Figure 1) indicates the approximate location of the contaminated water storage tank, and General Details (Part III Figure 5) provides a representative detail of the tank with secondary containment berm. Final disposition of the contaminated water will be by permitted discharge into an existing sanitary sewer line at the site, for treatment at an authorized wastewater treatment plant. As a contingency, Nexus will have the ability to truck-haul wastewater to a permitted wastewater treatment plant.

Conducting the processing operations within a partially enclosed building will provide noise pollution control, as the walls on the three sides of the building will direct noise from operations to the interior of the site. The building is located on an industrial site, and is immediately surrounded by other industrial sites, as well as Nexus-owned property to the north, west and east. In addition, the tree and brush covered terrain at the property boundaries will provide additional

mitigation of any noise that may emanate from the operation. Current Nexus operations at this site have not generated any noise complaints.

2.3 Sanitation

§330.63(b)(3)

The material recovery and transfer station will receive C&D material, MSW and commingled or source-separated recyclable material; and will be designed to facilitate appropriate cleaning for these types of materials. Surface water run-on will be prevented by a raised tipping floor surface and storage areas. In addition, all material stored onsite will be stored in roll-off boxes or transfer trailers and covered to prevent surface water contamination. Floors shall be constructed of reinforced concrete to facilitate cleaning and scrubbing, and will be swept and cleaned with pressure hoses as necessary to maintain a reasonably clean environment. Water will be available at various locations to allow for use of hoses for cleaning. After cleaning in designated processing areas, the water will be collected in floor drains located both on the tipping floor and in the transfer-trailer load-out area. The collected water will be stored in a contaminated water storage tank onsite and directed to the sanitary sewer line onsite for disposal. Alternately, the contaminated water may be hauled by truck to a permitted wastewater treatment plant. In all cases final disposal of the contaminated water will take place prior to the tank reaching 70% storage capacity.

2.4 Water Pollution Control

§330.63(b)(4)

The only proposed process that will generate wastewater is the occasional cleanup of the tipping floor and transfer-trailer load-out area. As described above, the wastewater generated from this activity will be collected and stored in onsite storage tank(s) or directed to the onsite sanitary sewer line for disposal. Neither MSW nor contaminated water will be discharged or released from the facility in any manner or form that will result in water pollution. All wastewater will be treated by a permitted treatment facility in compliance with all applicable rules of the TCEQ.

2.5 Endangered Species Protection

§330.63(b)(5)

As discussed in Part II, Section 15 and in Part II, Attachment C; the facility and its operation will not result in the destruction or adverse modification of the critical habitat of endangered or threatened species, or cause or contribute to the taking of any endangered or threatened species. Therefore, no special design features are needed.

3.0 FACILITY SURFACE WATER PROTECTION

30 TAC §330.63(c)

The facility design complies with the requirements of 30 TAC §330.303 – Surface Water Drainage for Municipal Solid Waste Facilities. The proposed facility will be constructed, operated and maintained to manage run-on and runoff during the peak discharge of a 25-year rainfall event, and will prevent the off site discharge of waste, feedstock materials, contaminated water, and in-process and/or processed materials. Surface water drainage in and around the facility will be controlled to minimize surface water running onto, into, and off of the site.

3.1 Drainage Analyses

§330.63(c)(1)

A detailed Surface Water Drainage Report is provided in Part III, Attachment A. The Nexus Facility proposes "redevelopment" of their western tract along Cunningham Road and "in-fill development" of their eastern tract along Thomas Road. This development will increase the amount of impervious cover on the property. Development plans call for routing storm-water run-on and runoff to existing ditches along Cunningham and Thomas Roads. The existing sheet flow conditions across both the eastern and western tracts will be mostly eliminated by the proposed development.

Drawings showing the general existing drainage areas (prior to site development) used in the drainage calculations are included in the detailed Surface Water Drainage Report (Part III, Attachment A).

The proposed Site Drainage Plan (Part III Figure 3) provides a plan view of the proposed internal drainage after development of the site. Cross sections of proposed drainage features are shown on General Details (Part III Figures 7-8). In general, the proposed trapezoidal channel on the northern boundary of the eastern tract (in the adjoining Nexus property) has been designed to accommodate a total maximum run-on flow of approximately 30 cubic feet per second. With a

bottom width of five-feet and 3:1 sideslopes, calculated maximum flow depth will be less than 2 feet at maximum velocity of approximately 2 feet per second. Run-on for the western portion of the site (entrance drive from Cunningham Road) will be controlled by means a constructed drainage ditch that will route water to the existing ditches on Cunningham Road. Run-off from the eastern Nexus tract will be a combination of sheet flow and channelized flow that directs run-off to either of two underground detention tanks. Although the site does not require detention to preserve existing drainage patterns, it should be noted that Harris County has specific detention volume requirements. For areas greater than 1 acre, a detention volume of 0.50 acre-feet per acre of increased impervious cover is required. For areas less than one-acre, a detention volume of 0.2 acre-feet per acre of increased impervious cover is required. For the 3.6-acre east tract, a maximum detention volume of 1.8 acre-feet is required. For the 0.9-acre west tract, a maximum detention volume of 0.18 acre-feet is required. Detention for the east tract will consist of two 300,000 gallon underground storage tanks. Detention for the west tract will consist of storage in combination with the concrete channel.

Calculations are provided in the Surface Water Drainage Report (Part III, Attachment A) to demonstrate that existing drainage patterns will not be adversely affected and the method of analysis and assumptions used are included.

Drainage calculations are shown in the Surface Water Drainage Report (Part III, Attachment A) for existing conditions and the proposed development so that effects of development could be evaluated. Peak discharge was calculated for both 25-year and 100-year storms using TxDOT and City of Houston Rational Method as well as the NRCS TR-55 Method. Storm runoff volume and peak discharges, without the effects of required stormwater detention, were also calculated. Although the Rational Methods showed post-development increases in peak discharge, TR-55 methods showed little increase in peak discharge. Runoff volume increases were negligible even without considering detention. On site drainage analyses can be seen on Part III, Figure 3. On site drainage calculations are based for full build out of the facilities as

shown on Part III, Figure 1. All drainage facilities must also comply with Harris County requirements and are subject to revisions during final design.

3.2 Flood Control and Analyses

§330.63(c)(2)

The Nexus facility is not located within the 100-year floodplain, as shown on the most current Flood Insurance Rate Map (FIRM) prepared by the Federal Emergency Management Agency (FEMA). A copy of this map is included in Part II, Figure 6.

4.0 WASTE MANAGEMENT UNIT DESIGN

30 TAC §330.63(d)

All incoming material brought to the facility will be off-loaded and processed rapidly on the tipping floor of the facility. Non-recyclable waste will be transferred to transfer trailers and hauled to a properly permitted landfill when the transfer trailer reaches capacity. If it is not possible to remove the non-recyclable waste at the end of the day, the waste will be covered to prevent the creation of nuisance conditions or public health concerns. The non-recyclable waste will be stored onsite for no more than 72 hours.

The tipping floor will be graded toward floor drains, and will not allow any contaminated water to run off of the tipping floor or transfer-trailer loading area. The processing area will be covered and elevated, and therefore will not be inundated by run-on resulting from the 25-year rainfall event. Roll-offs, transfer trailers, and other containers will be covered when they contain waste or recyclable material. Pipes will carry the contaminated water from the points of collection to the contaminated water storage tank or directly to the sewer system. The tank will be dual contained, and will have a minimum capacity of 5,000 gallons. The design of any tank will be such that contaminated water can be pumped through a force main to the sanitary sewer system. Nexus operators will be able to visually determine the level of the tank during daily operations. The tank will be emptied prior to reaching 70% capacity. Since the tank will be fully enclosed, it will not be required to accommodate a 25-year, 24-hour rainfall event per 30 TAC §330.63(d)(1)(B). If secondary containment is provided by berms or dikes, the capacity of the secondary containment will hold the largest tank volume plus the 25-year, 24-hour storm.

The facility proposes to operate up to 24 hours per day seven days per week. Therefore, minimal storage of materials onsite is anticipated, with a maximum storage period for MSW of 72 hours. TCEQ authorization will be requested to exceed this storage period during unusual events such as natural disaster situations. The maximum time limit for the storage of recyclable commodities is 180 days.

Please note that none of the following features apply to this facility:

- Incineration units
- Surface impoundments
- Landfill units
- Arid exemption landfill units
- Mobile liquid waste processing units
- Type IX energy, material, gas recovery for beneficial use
- Compost units
- Type VI waste processing demonstration units

5.0 GEOLOGY REPORT

30 TAC §330.63(e)

The facility is not a landfill or compost unit, therefore, a Geology Report is not required, unless otherwise requested by the executive director of TCEQ.

6.0 GROUNDWATER SAMPLING AND ANALYSIS PLAN

30 TAC §330.63(f)

The facility is not a landfill or compost unit, therefore, a Groundwater Sampling and Analysis Plan is not required, unless otherwise requested by the executive director of TCEQ.

7.0 LANDFILL GAS MANAGEMENT PLAN

30 TAC §330.63(g)

The facility is not a landfill, therefore, a Landfill Gas Management Plan is not required, unless otherwise requested by the executive director of TCEQ.

8.0 CLOSURE PLAN

30 TAC §330.63(h)

This closure plan is presented to address the requirements in 30 TAC §330.459 and 30 TAC §330.461. This closure plan will be utilized in conjunction with the applicable financial assurance requirements in 30 TAC Chapter 37 Subchapter R. In the event Nexus decides or is required to discontinue operation of the facility, closure will be initiated. Closure activities will include procurement of any needed contract services. All waste, waste residues, and any recovered materials will be collected and transported to recycling markets or a permitted disposal facility as required by 30 TAC §330.459(b). It is understood that if there is evidence of a release from a municipal solid waste unit, the executive director may require an investigation into the nature and extent of the release and an assessment of measures necessary to correct an impact to groundwater, as required by 30 TAC §330.459(c). A general cleanup (litter removal and washdown of all operating surfaces) and disinfection and decontamination of the site will be performed to include all equipment, wash down water/media, contaminated water handling units, tipping areas, processing areas, post-processing areas, and vector control. The contaminated water tank will be emptied and the discharge will be pumped through a force main into the sanitary sewer system as permitted or hauled via tanker truck. Subsequent to all cleanup activities, the contaminated water tank will be decommissioned. The tank and secondary containment system will be excavated and removed for disposal and the area filled with clean soil. The underground stormwater detention tanks are proposed to remain on site for run-off control. The site will be secured as appropriate, and all utilities disconnected. A sign stating that the facility is closed will be posted at all facility entrances. All buildings and access gates will be locked. Additional fencing may be installed if deemed necessary at that time. Closure and completion of cleanup will be certified as required. If Nexus desires to use the site for other uses, a request for permission to leave the equipment in place following closure will be submitted at that time.

Nexus will store combustible materials outdoors, and therefore, will comply with the following additional closure requirements specified in 30 TAC §330.459(d). First, closure will include

collecting processed and unprocessed materials, and transporting these materials to an authorized facility for disposition unless otherwise approved or directed in writing by the executive director. Also, closure of the facility will be completed within 180 days following the most recent acceptance of processed or unprocessed materials, unless otherwise directed or approved by the executive director.

The following describes a general schedule for closure activities pursuant to 30 TAC §330.461:

- No later than 90 days prior to initiation of final facility closure, Nexus will publish a public notice of final closure in newspaper(s) of largest circulation in the vicinity of the facility (Houston, Harris County). The notice will include the name, address, physical location of the facility, registration number, and the date of final receipt of waste. Additional copies of the closure plan will be available for public access and review. Nexus will also provide written notification to the executive director of the intent to close the facility and place this notice of intent in the operating record.
- At the time of submittal of the written notice to the executive director, a sign will be posted at the main entrance to the facility (and all other frequently used access points, if any) and at appropriate points around the site perimeter notifying persons of the date of final closure. The sign(s) will contain the date of closing and the prohibition against further receipt of waste materials after the stated closure date, in compliance with 30 TAC §330.461(b).
- Barriers will be installed at all gates or access points to prevent unauthorized dumping.
- Facility closure will be completed within 180 days following the most recent acceptance of processed or unprocessed materials, unless otherwise directed or approved by the executive director.
- Per 30 TAC §330.461(c), within 10 days after completion of closure activities of the facility, Nexus will submit the following:
    - A certification and all applicable documentation from an independent Professional Engineer verifying that closure has been completed in accordance with the final closure plan in accordance with 30 TAC §330.461(c). After the

Commission has approved the certification, a copy will be placed in the operating record.

- A request for voluntary revocation of the facility registration.

Nexus will be closed as a "clean closure," meaning that no recyclable material and no regulated municipal solid waste will remain at the closed facility. Consequently, Nexus will not be required to prepare and file in the Deed Records of Harris County an "affidavit to the public" in accordance with the requirements of 30 TAC §330.19 and 30 TAC §330.457(g). Since Nexus will be closed as a "clean closure", the facility will not require post-closure care under TCEQ rules. Therefore, Nexus will submit to the executive director a request for the voluntary revocation of the facility's registration.

9.0 POST-CLOSURE PLAN

30 TAC §330.63(i)

No TCEQ-regulated waste will remain on site following closure of the facility. Therefore, the facility is not subject to the post-closure care requirements specified in 30 TAC §330.463.

10.0 COST ESTIMATE FOR CLOSURE AND POST-CLOSURE CARE

30 TAC §330.63(j)

Nexus proposes to operate a waste separation/recycling facility and transfer station, and to store combustible materials outdoors, and in accordance with 30 TAC §330.505(a) provides the cost estimate for closure below. This closure cost estimate presents costs in current dollars reflecting the hiring of a third party to close the processing facility by disposition of all processed and unprocessed material in accordance with applicable regulations. This closure and disposition of materials is assumed to be accomplished by a third party unaffiliated with Nexus, and is based on quantity measurements for collection and disposition of all materials.

The following table summarizes the closure cost estimate. The table is followed by notes on specific elements of the closure represented in the cost estimate.

Table III-1: Closure Cost Estimate (2011 Dollars)

CATEGORY	DESCRIPTION	QUANTITY	UNIT	UNIT COSTS	TOTAL COSTS
ADMINISTRATION (1)	Site Survey and Review of Closure Requirements	16	Hr	$140.00	$2,240.00
	Prepare Plans and Specifications	20	Hr	$140.00	$2,800.00
	Bid/Contract Administration	20	Hr	$100.00	$2,000.00
	Clerical	8	Hr	$60.00	$480.00
				SUBTOTAL	**$7,520.00**
SITE CLEAN-UP	Cleanup/Removal of On-Site Waste Residuals/Litter	16	Hr	$40.00	$640.00
	Transport and Disposal of MSW (2)	900	Ton	$75.00	$67,500.00
	Facility Wash Down and Disinfection	32	Hr	$40.00	$1,280.00
	Contaminated Water Tank Decommission and Removal (3)	1	LS	$5,000.00	$5,000.00
	Access Barrier Installation	1	LS	$2,500.00	$2,500.00
	Recyclables removal (4)	500	CY	$7.00	$3,500.00
				SUBTOTAL	**$80,420.00**
SIGN INSTALLATION	Sign Manufacturing and Installation	1	LS	$500.00	$500.00
	Public Notice	1	LS	$250.00	$250.00
				SUBTOTAL	**$750.00**
CERTIFICATION	Perform Site Inspection and Prepare Certification of Closure	16	Hr	$140.00	$2,240.00
	Legal Fees for Deed Modification	25	Hr	$200.00	$5,000.00
				SUBTOTAL	**$7,240.00**
CONTINGENCY	Contingency (10%)	1	LS	10%	**$9,593.00**
TOTAL ESTIMATED CLOSURE COST					**$105,523.00**

Closure Cost Table notes:

1. Administration costs reflect costs of a third-party firm to determine, contract for, and/or execute the closure tasks.
2. Tons of MSW reflects the worst case scenario, in which it is assumed that the maximum daily capacity of the facility will need disposal. This is 5,000 CY, or 1,000 tons minus the minimum 10% recyclable portion. The unit cost assumes transportation charge, loading, and disposal, at $75.00 per ton.
3. Contaminated Water tank removal includes decontamination of tank and appurtenances, as well as removal of any secondary containment liner and berm. Materials will be decontaminated and disposed of properly.
4. Cubic yards of recyclables reflects the minimum (10%) recyclables at the maximum facility capacity. This equates to 500 CY for disposal.

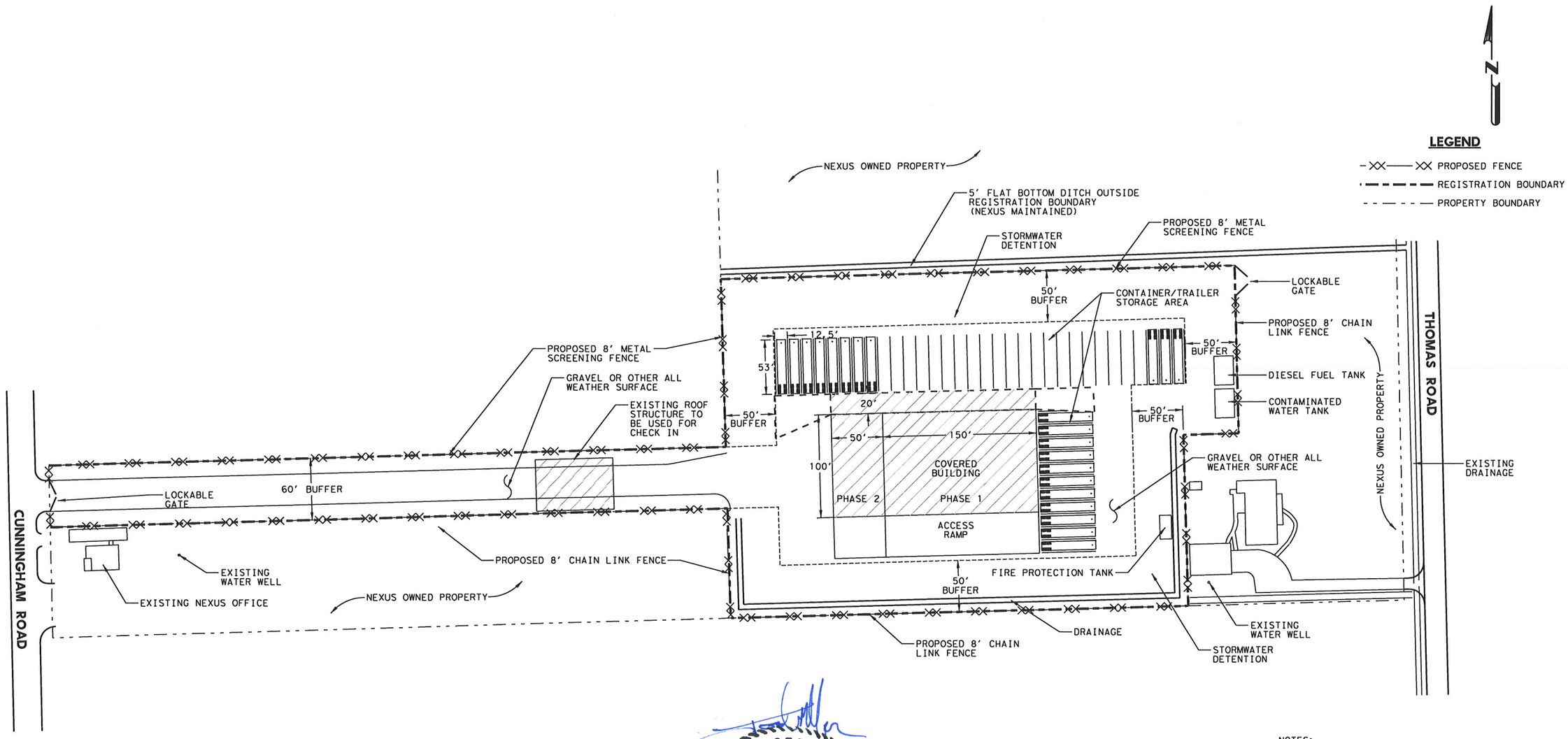
As shown, total closure cost for the proposed facility, in accordance with 30 TAC §330.505(a) is $105,523 in 2011 dollars. Nexus will provide an increase in the closure cost estimate if changes to the closure plan or the facility conditions increase the maximum cost of closure, at any time during the active life of the facility.

Nexus will submit the required documentation for financial assurance at least 60 days prior to the initial receipt of waste as specified in 30 TAC §330.63(j). Financial assurance coverage will be maintained until all aspects of the closure plan have been completed and the site is determined to be closed, in writing, by the TCEQ.

Since the facility will be "clean closed" and no TCEQ-regulated waste will remain on-site, post closure care will not be required. Accordingly, no post-closure care cost estimate is required. A registration amendment or modification will be required if any changes in the proposed operation, including those which may result in a need for a post-closure care plan and cost estimate are implemented. If a registration amendment or modification is required or requested

by the Executive Director, the appropriate post-closure care plan and cost estimate will be developed at that time.

Figures



STATE OF TEXAS
JOEL B. MILLER
103847
LICENSED
PROFESSIONAL ENGINEER
10·27·11

NOTES:

1. PROPERTY ADDRESS
   6124 CUNNINGHAM ROAD
   6131 THOMAS ROAD
2. ALL DEVELOPMENT PERMITS REQUIRED BY HARRIS COUNTY WILL BE OBTAINED PRIOR TO OPERATION UNDER THIS REGISTRATION.
3. STORAGE AREA FOR MSW AND RECYCLABLES IS SUFFICIENT FOR 43 125 C.Y. TRANSFER TRAILERS.

DATE: 10/26/2011
TIME: 12:19:31 PM
USER: rcox
FILE: Nexus\Disposal\Nexus\TS\Registration\13.00\CAD\Sheet Files
PLTDRVER:11X17LASER\BW\PDF.plt
PENTABLE:NEW HDR\ERM.tbl

NEXUS CONTINUUM

HDR
HDR Engineering, Inc.
4500 W. Eldorado Parkway
Suite 3500
McKinney, Texas 75070
Texas P.E. Firm
Firm Registration No.F-754

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	M.ODEN
ENGINEER	M.ODEN
CHECKED BY	
DESIGNED	
DRAWN BY	B.COX
QA/QC	
PROJECT NUMBER	142132

FOR PERMITTING ONLY. NOT FOR BIDDING, OR CONSTRUCTION.
Prepared by or under the Direct Supervision of
JOEL B. MILLER, P.E. 103847
10/26/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

FACILITY LAYOUT
MATERIAL RECOVERY AND TRANSFER STATION

0 50' 100'

FILENAME	N_SL08.dgn
SCALE	

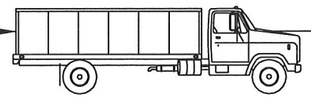
SHEET
PART III
FIGURE 1

GENERATOR

- PLASTIC
- CORRUGATED CARDBOARD
- PAPER
- ALUMINUM/ NON-FERROUS METAL
- FERROUS METAL
- EXCAVATED SOIL
- CONCRETE/MASONRY
- WOOD/BRUSH
- LUMBER
- OTHER RECYCLABLE
- NON-RECYCLABLE (MSW)

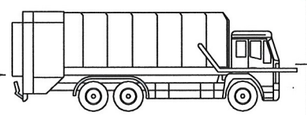
TRANSPORTATION

ROLL-OFF CONTAINER (COMMINGLED)



ROLL-OFF / DUMP TRUCK

MSW DUMPSTER



COMMERCIAL COLLECTION VEHICLE

UNACCEPTABLE WASTE/MATERIAL

TO GENERATOR

PROCESSING

TIPPING FLOOR

STORAGE

- SOIL
- CONCRETE/MASONRY
- WOOD/BRUSH
- LUMBER
- PLASTIC
- CORRUGATED CARDBOARD
- PAPER
- ALUMINUM/ NON-FERROUS METAL
- FERROUS METAL
- OTHER RECYCLABLE
- NON-RECYCLABLE (MSW)

DISPOSITION

- OFFSITE USE FOR FILL
- OFFSITE FOR AGGREGATE, FILL OR OTHER USE
- OFFSITE FOR COMPOST OR COMMODITY
- COMMODITY MARKETS
- VARIES BY COMMODITY
- TO LANDFILL OR OTHER AUTHORIZED DISPOSAL

STATE OF TEXAS
JOEL B. MILLER
103847
LICENSED
PROFESSIONAL ENGINEER

10.27.11

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Prepared by or under the Direct Supervision of
JOEL B. MILLER, P.E. 103847
10/26/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

PROCESS FLOW DIAGRAM

NEXUS CONTINUUM

HDR
HDR Engineering, Inc.
4500 W. Eldorado Parkway
Suite 3500
McKinney, Texas 75070

Texas P.E. Firm
Firm Registration No.F-754

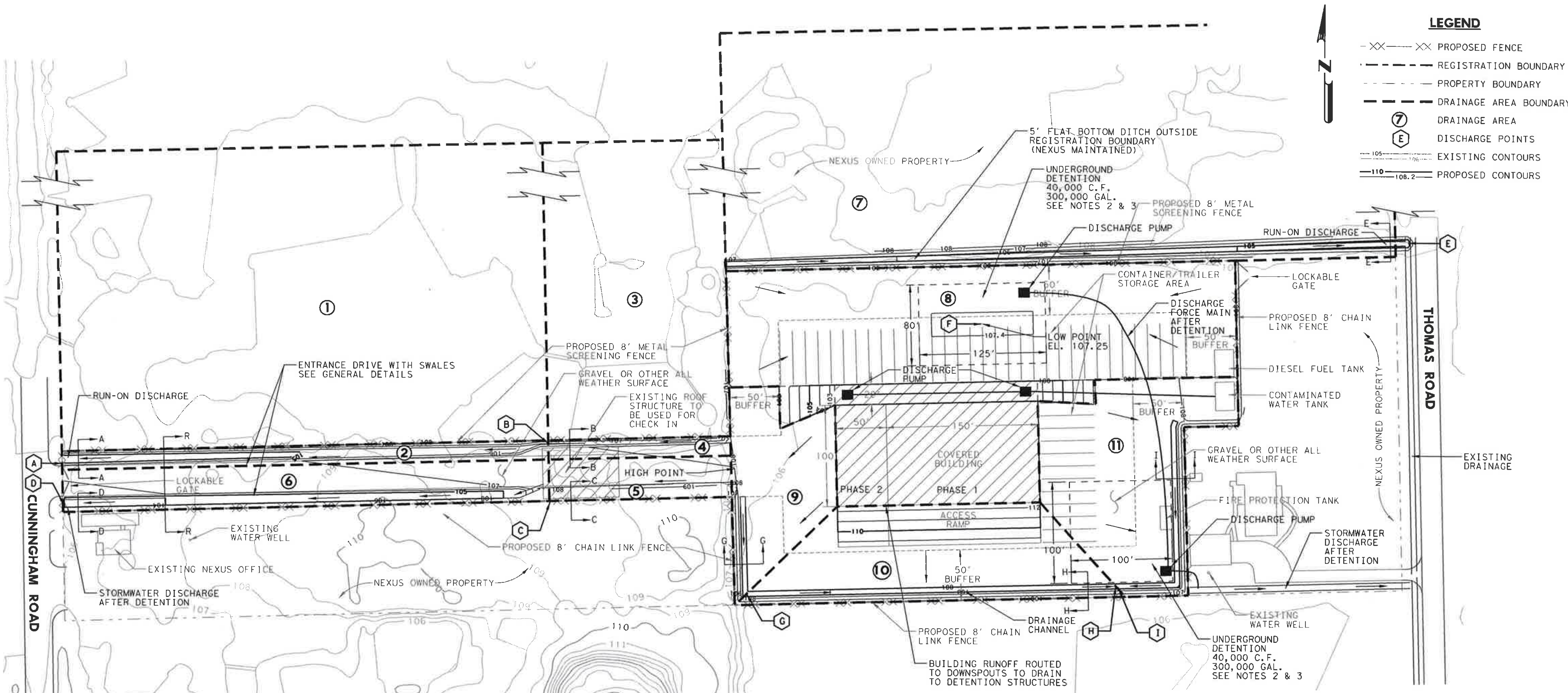
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	M.ODEN
ENGINEER	M.ODEN
CHECKED BY	
DESIGNED	
DRAWN BY	B.COX
QA/QC	
PROJECT NUMBER	142132

FILENAME	N_PFD02.dgn
SCALE	

SHEET
PART III
FIGURE 2

DATE: 10/26/2011
TIME: 12:22:05 PM
USER: rcox
FILE: Nexus*Disposal\Nexus*TS*Registration\13.00*CAD\Sheet Files
PLTDRVER:11X17LASER*BW*PDF.plt
PENTABLE:NEW HDR*ERM.tbl



Area ID	Discharge Point	Area (Acres)	C	T_c (Minutes)	I_{25} (In/Hr)	Q_{25} (cfs)	Section	Comment
1		9.92	0.6	12	9.36	61.27		Offsite
2		0.17	0.75	10	10.11	1.38		
3		3.72	0.6	12	9.36	22.98		Offsite
4		0.06	0.75	10	10.11	0.52		
3 + 4	B	3.78	0.6	12.5	9.19	23.03	B-B	
1+2+3+4	A	13.86	0.6	14.3	8.64	79.39	A-A	
5	C	0.19	0.75	10	10.11	1.55	C-C	
6		0.5	0.75	10	10.11	4.14		
5 + 6	D	0.69	0.75	10	10.11	5.69	D-D	
7	E	13.64	0.35	30	5.85	30.72	E-E	Offsite
8	F	1.94	0.75	10	10.11	16.22	none	
9	G	0.36	0.75	10	10.11	3	G-G	
10		0.64	0.75	10	10.11	5.32		
9 + 10	H	1	0.75	10	10.11	8.33	H-H	
11	I	0.65	0.75	10	10.11	5.45	I-I	

NOTES:

1. PROPERTY ADDRESS
   6124 CUNNINGHAM ROAD
   6131 THOMAS ROAD
2. DETENTION STORAGE TO MEET HARRIS COUNTY DEVELOPMENT REQUIREMENTS.
3. ESTIMATED LATERAL DIMENSIONS OF DETENTION BASED ON ASSUMED DEPTH TO GROUNDWATER OF APPROXIMATELY SIX FEET BELOW GRADE. SEE GENERAL DETAILS FOR DETENTION OPTIONS.
4. ALL DEVELOPMENT PERMITS REQUIRED BY HARRIS COUNTY WILL BE OBTAINED PRIOR TO OPERATION UNDER THIS REGISTRATION.

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED PROFESSIONAL ENGINEER
10-27-2011

NEXUS CONTINUUM

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McKinney, Texas 75070

Texas P.E. Firm
Firm Registration No.F-754

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PROJECT MANAGER	M.ODEN
ENGINEER	M.ODEN
CHECKED BY	
DESIGNED	
DRAWN BY	B.COX
QA/QC	
PROJECT NUMBER	142132

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MICHAEL W. ODEN, P.E. 67165
10/28/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

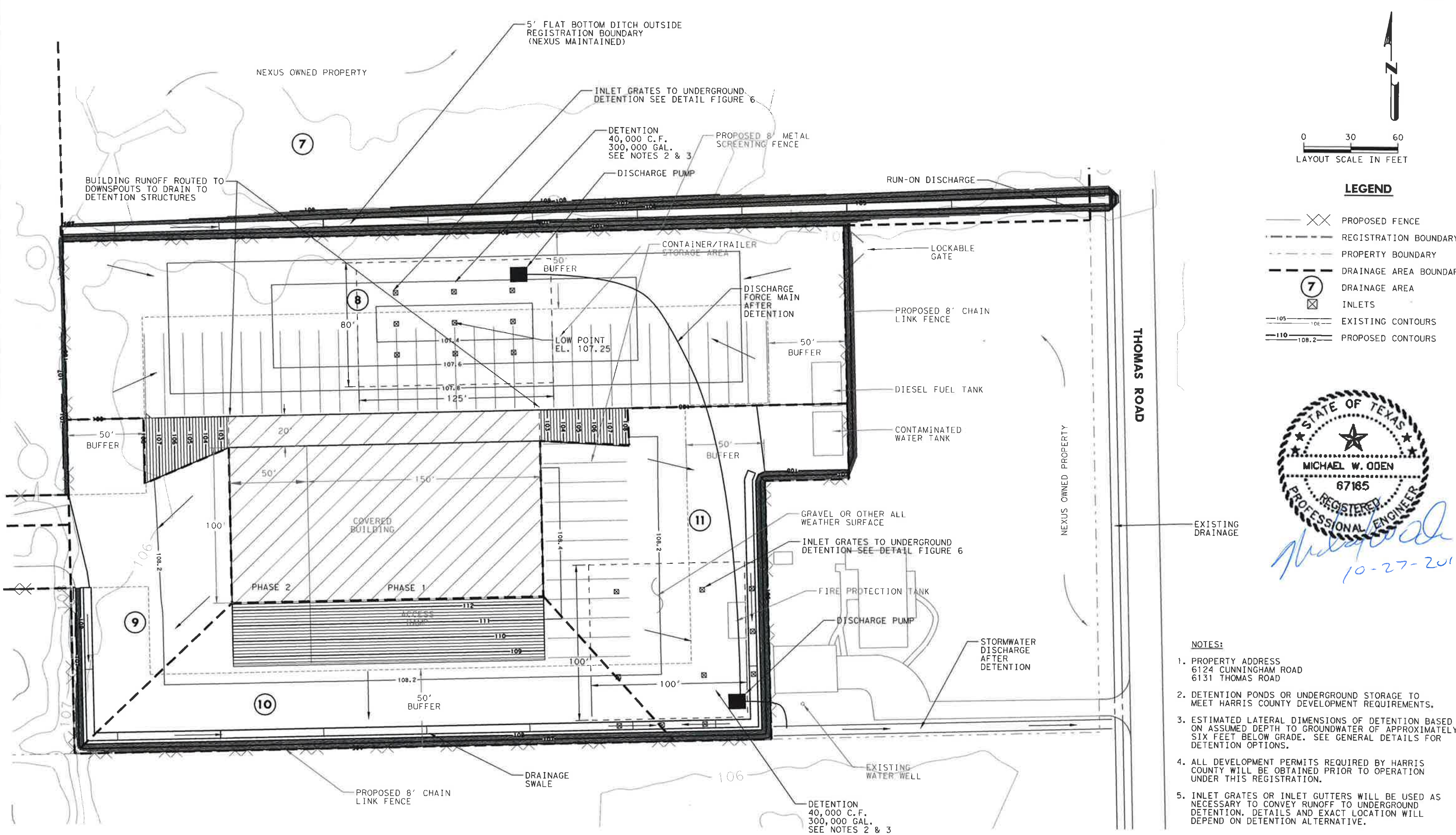
OVERALL SITE DRAINAGE PLAN
DEVELOPED CONDITIONS

0 50' 100'
SCALE

FILENAME N_SD03.dgn

SHEET
PART III
FIGURE 3

DATE: 10/26/2011
TIME: 12:43:14 PM



LEGEND

- PROPOSED FENCE
- REGISTRATION BOUNDARY
- PROPERTY BOUNDARY
- DRAINAGE AREA BOUNDARY
- DRAINAGE AREA
- INLETS
- EXISTING CONTOURS
- PROPOSED CONTOURS

NOTES:

1. PROPERTY ADDRESS
   6124 CUNNINGHAM ROAD
   6131 THOMAS ROAD
2. DETENTION PONDS OR UNDERGROUND STORAGE TO MEET HARRIS COUNTY DEVELOPMENT REQUIREMENTS.
3. ESTIMATED LATERAL DIMENSIONS OF DETENTION BASED ON ASSUMED DEPTH TO GROUNDWATER OF APPROXIMATELY SIX FEET BELOW GRADE. SEE GENERAL DETAILS FOR DETENTION OPTIONS.
4. ALL DEVELOPMENT PERMITS REQUIRED BY HARRIS COUNTY WILL BE OBTAINED PRIOR TO OPERATION UNDER THIS REGISTRATION.
5. INLET GRATES OR INLET GUTTERS WILL BE USED AS NECESSARY TO CONVEY RUNOFF TO UNDERGROUND DETENTION. DETAILS AND EXACT LOCATION WILL DEPEND ON DETENTION ALTERNATIVE.

NEXUS CONTINUUM

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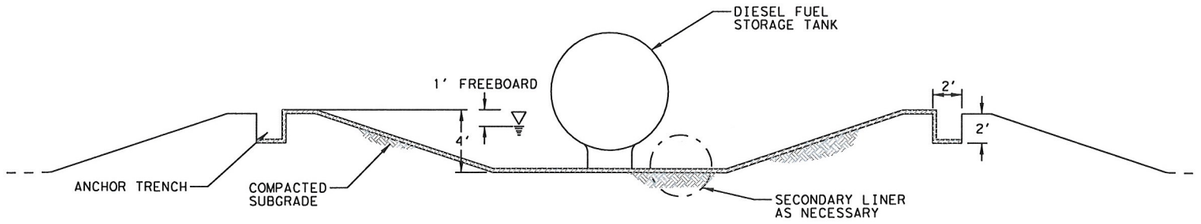
MICHAEL W. ODEN, P.E. 67165
10/26/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

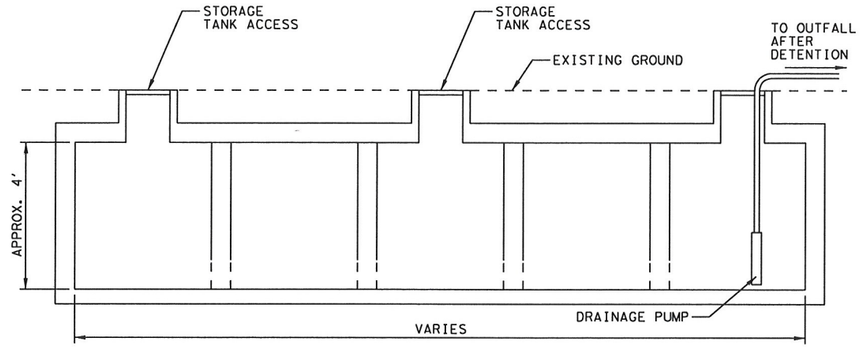
SITE DRAINAGE PLAN DEVELOPED CONDITIONS

FILENAME N_DSD01.dgn
SCALE

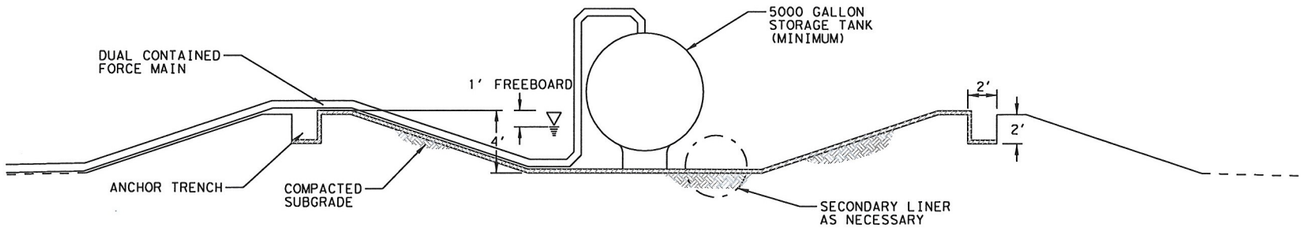
SHEET
PART III
FIGURE 4



TYPICAL DIESEL FUEL TANK
N. T. S.

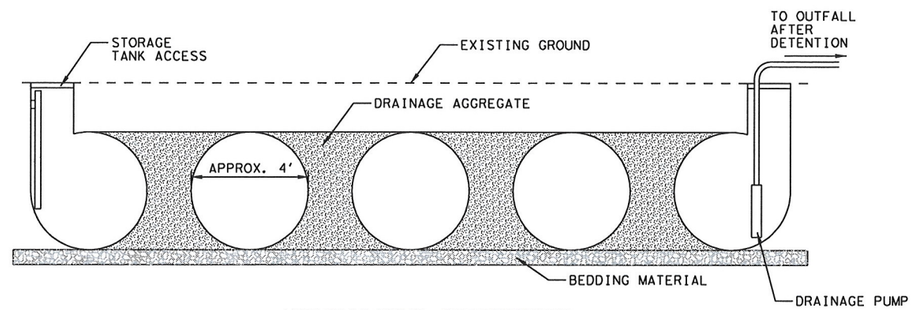


UNDERGROUND STORMWATER DETENTION OPTION A
N. T. S.



TYPICAL CONTAMINATED WATER STORAGE TANK AND BERM DETAILS
N. T. S.

NOTE: TANKS WITH BUILT IN SECONDARY CONTAINMENT WILL NOT REQUIRE BERM AND SECONDARY LINER FOR CONTAINMENT.



UNDERGROUND STORMWATER DETENTION OPTION B
N. T. S.

NOTES:

1. DESIGN AND DIMENSIONS OF DETENTION WILL BE DICTATED BY DESIGN, OPERATIONAL, AND EXISTING CONDITIONS. DEPTH TO GROUNDWATER WILL LIMIT VERTICAL DIMENSIONS.
2. INLET GRATES OR INLET GUTTERS WILL BE USED AS NECESSARY TO CONVEY RUNOFF TO UNDERGROUND DETENTION. DETAILS AND EXACT LOCATION WILL DEPEND ON DETENTION ALTERNATIVE.

STATE OF TEXAS
JOEL B. MILLER
103847
LICENSED
PROFESSIONAL ENGINEER
10.27.11

DATE: 10/26/2011
TIME: 12:47:05 PM
USER: rcox
FILE: Nexus*Disposal\Nexus*TS*Registration\13.00*CAD\Sheet Files PLTDRVER:11X17LASER*BW*PDF.plt PENTABLE:NEW HDR*ERM.tbl

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McKinney, Texas 75070
Texas P.E. Firm
Firm Registration No.F-754

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ENGINEER	M.ODEN
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DESIGNED	
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QA/QC	
PROJECT NUMBER	142132

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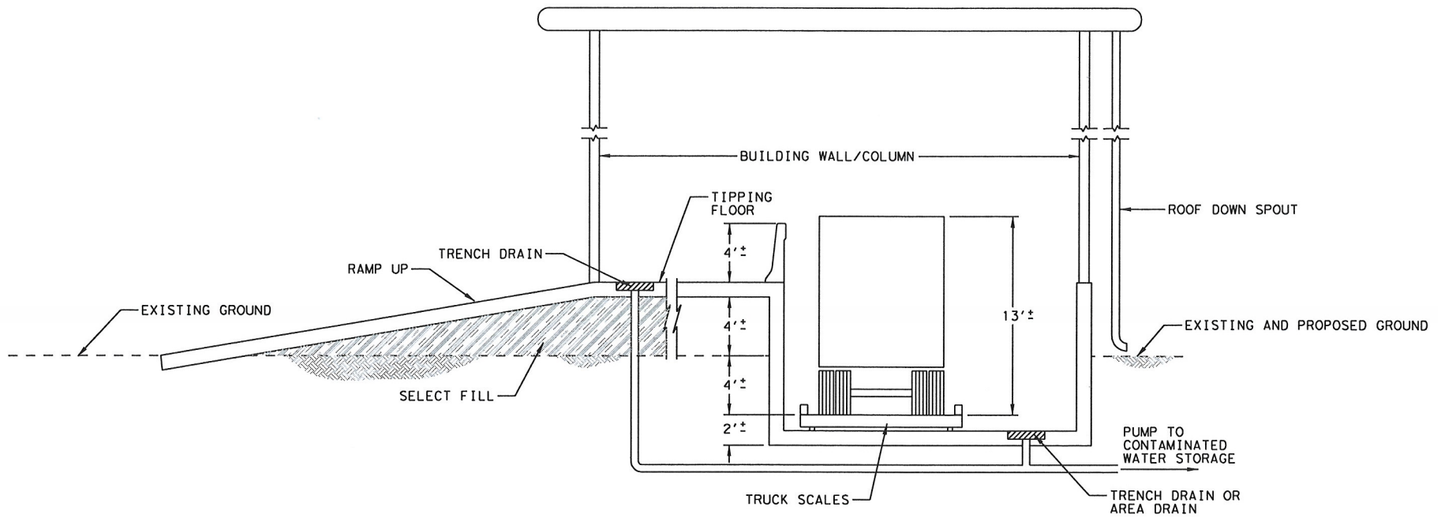
JOEL B. MILLER, P.E. 103847
10/26/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

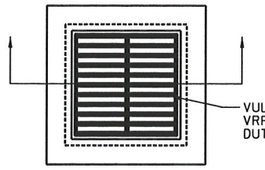
GENERAL DETAILS

FILENAME	N_GD01.dgn
SCALE	

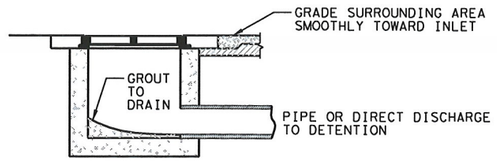
SHEET
PART III
FIGURE 5



SCHEMATIC CROSS SECTION
N. T. S.



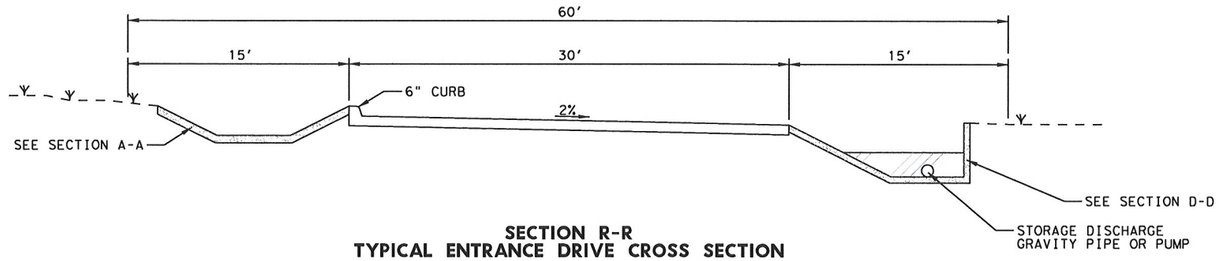
PLAN
N. T. S.



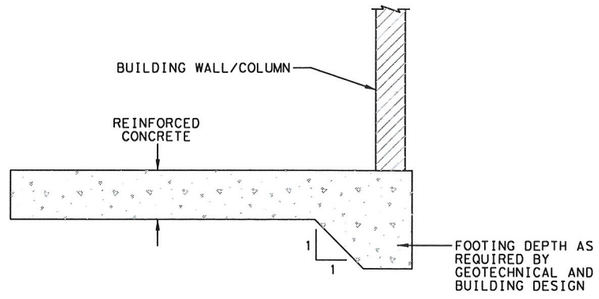
SECTION A-A
N. T. S.

GRATE INLET
N. T. S.

NOTE:
INLET GRATES OR INLET GUTTERS WILL BE USED AS NECESSARY TO CONVEY RUNOFF TO DETENTION. DETAILS AND EXACT LOCATION WILL DEPEND ON DETENTION ALTERNATIVE.



SECTION R-R
TYPICAL ENTRANCE DRIVE CROSS SECTION
N. T. S.



TYPICAL SLAB & FOOTING DETAILS
N. T. S.

STATE OF TEXAS
JOEL B. MILLER
103847
LICENSED
PROFESSIONAL ENGINEER

10-27-11

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JOEL B. MILLER, P.E. 103847
10/26/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

GENERAL DETAILS
CROSS SECTIONS

NEXUS CONTINUUM

HDR
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4500 W. Eldorado Parkway
Suite 3500
McKinney, Texas 75070

Texas P.E. Firm
Firm Registration No.F-754

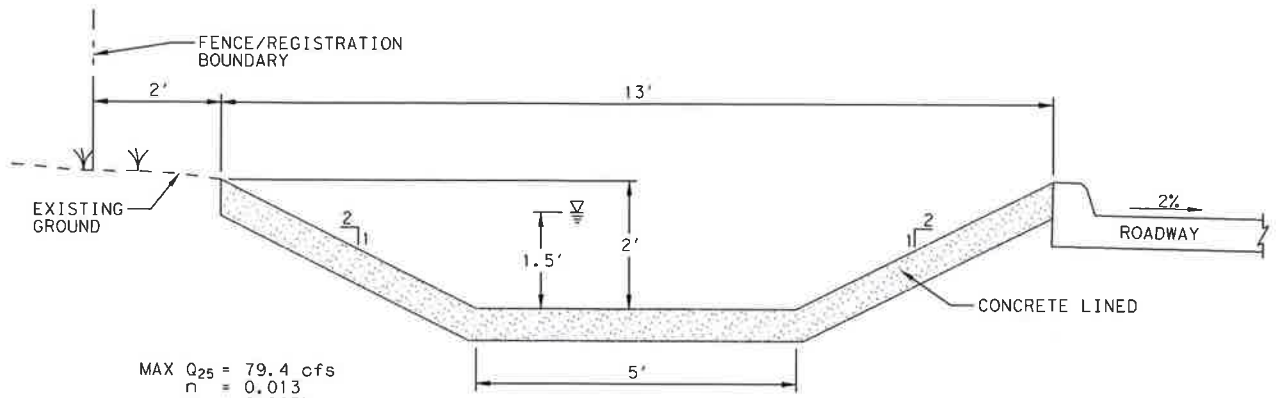
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	M.ODEN
ENGINEER	M.ODEN
CHECKED BY	
DESIGNED	
DRAWN BY	B.COX
QA/QC	
PROJECT NUMBER	142132

FILENAME	N_GD02.dgn
SCALE	

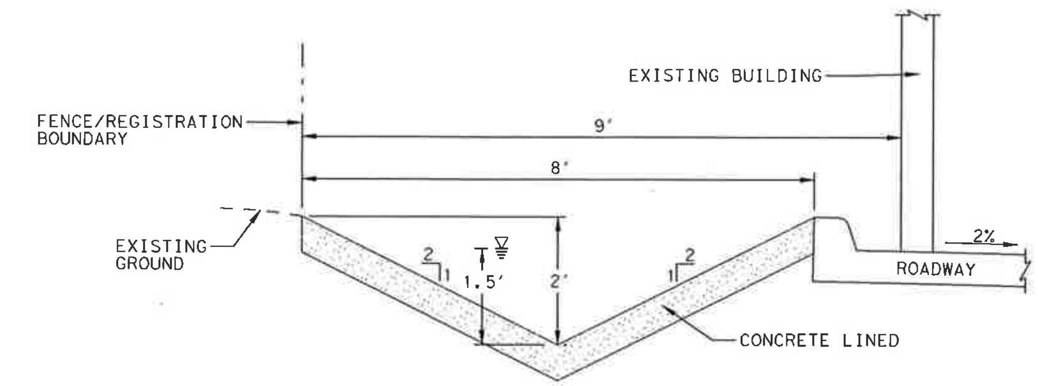
SHEET
PART III
FIGURE 6

DATE: 10/26/2011
TIME: 12:49:34 PM
USER: rcox
FILE: Nexus\Disposal\Nexus\TSAregistration\13.00\CAD\Sheet Files PLTDRIVER:11X17LASER+BW+PDF.plt PENTABLE:NEW HDR+ERM.tbl



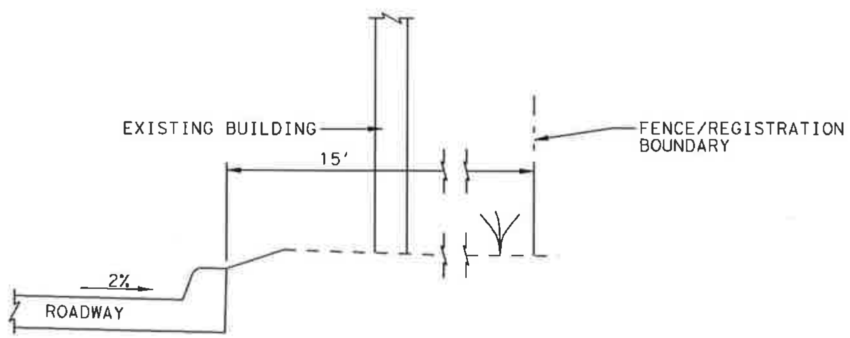
MAX Q_{25} = 79.4 cfs
n = 0.013
s = 0.003%
d = 1.53'
v = 6.43 fps

SECTION A-A
N.T.S.



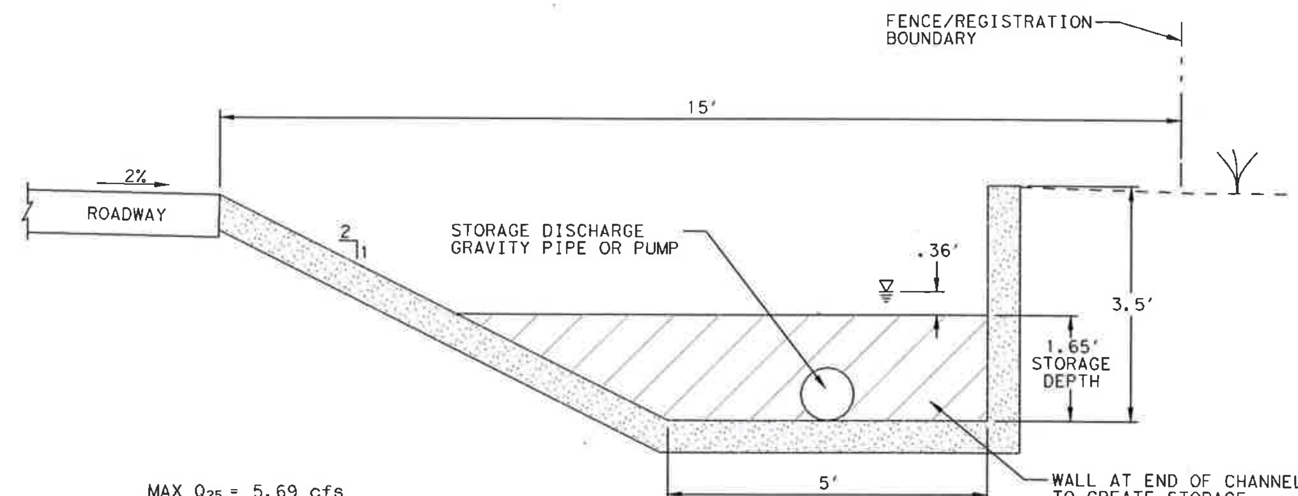
MAX Q_{25} = 23.00 cfs
n = 0.013
s = 0.003%
d = 1.54'
v = 4.87 fps

SECTION B-B
N.T.S.



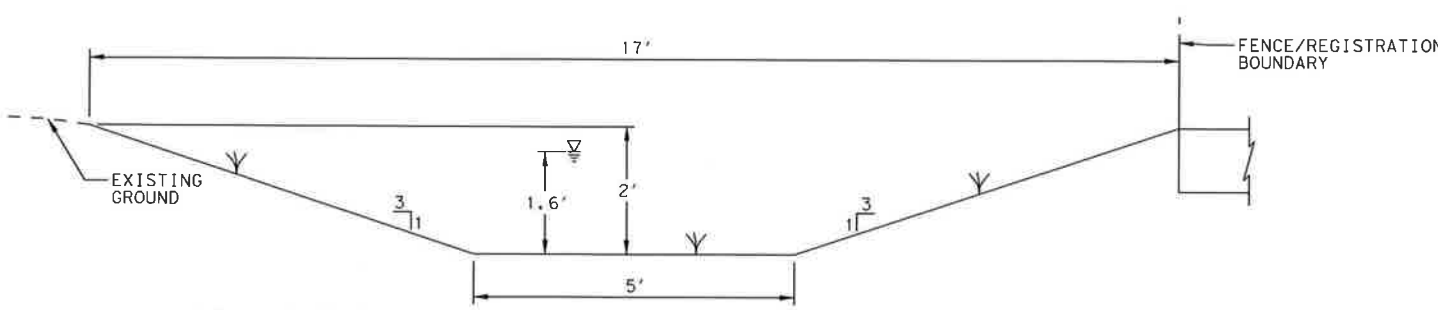
MAX Q_{25} = 1.55 cfs
n = 0.013
s = 0.003%
d = 0.21'
v = 1.38 fps

SECTION C-C
N.T.S.



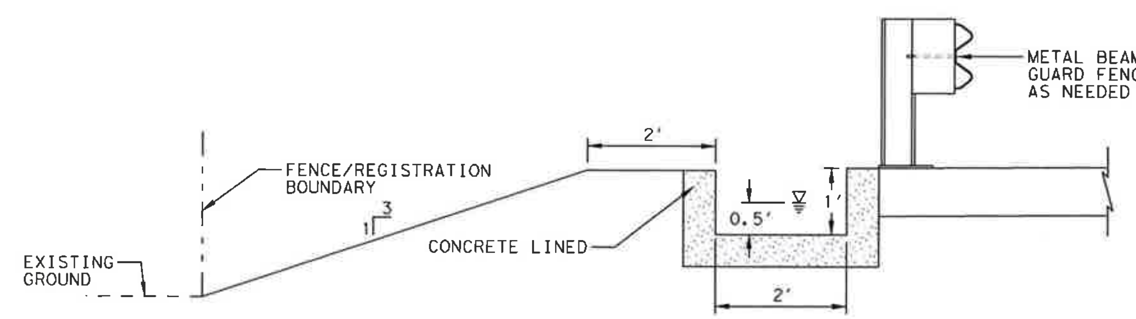
MAX Q_{25} = 5.69 cfs
n = 0.013
s = 0.003%
d = 0.36'
v = 2.91 fps

SECTION D-D
N.T.S.



MAX Q_{25} = 30.72 cfs
n = 0.045
s = 0.003%
d = 1.64'
v = 1.88 fps

SECTION E-E
N.T.S.



MAX Q_{25} = 3.00 cfs
n = 0.013
s = 0.003%
d = 0.5'
v = 3.01 fps

SECTION G-G
N.T.S.

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER
10-27-2011

NEXUS CONTINUUM

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Firm Registration No.F-754

ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	M.ODEN
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QA/QC	
PROJECT NUMBER	142132

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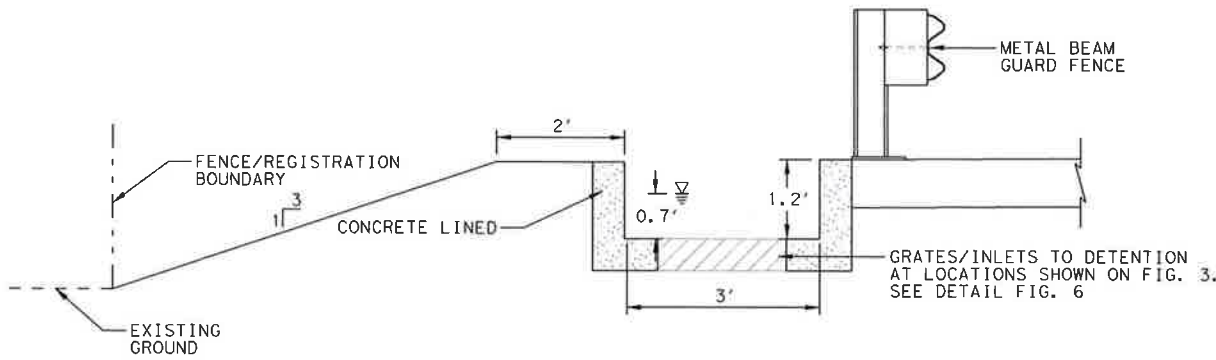
Prepared by or under the Direct Supervision of
MICHAEL W. ODEN, P.E. 67165
$$DATE$$

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

GENERAL DETAILS
CROSS SECTIONS

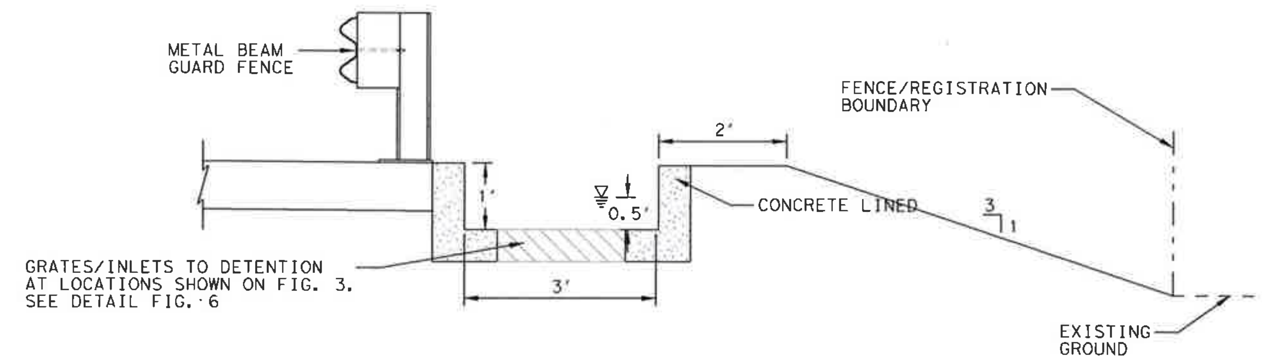
FILENAME	N_GD03.dgn
SCALE	

SHEET
PART III
FIGURE 7



MAX Q_{25} = 8.33 cfs
n = 0.013
s = 0.003%
d = 0.72'
v = 3.87 fps

SECTION H-H
N.T.S.



MAX Q_{25} = 5.45 cfs
n = 0.013
s = 0.003%
d = 0.54'
v = 3.38 fps

SECTION I-I
N.T.S.

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER
10-27-2011

NEXUS CONTINUUM

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10/26/2011

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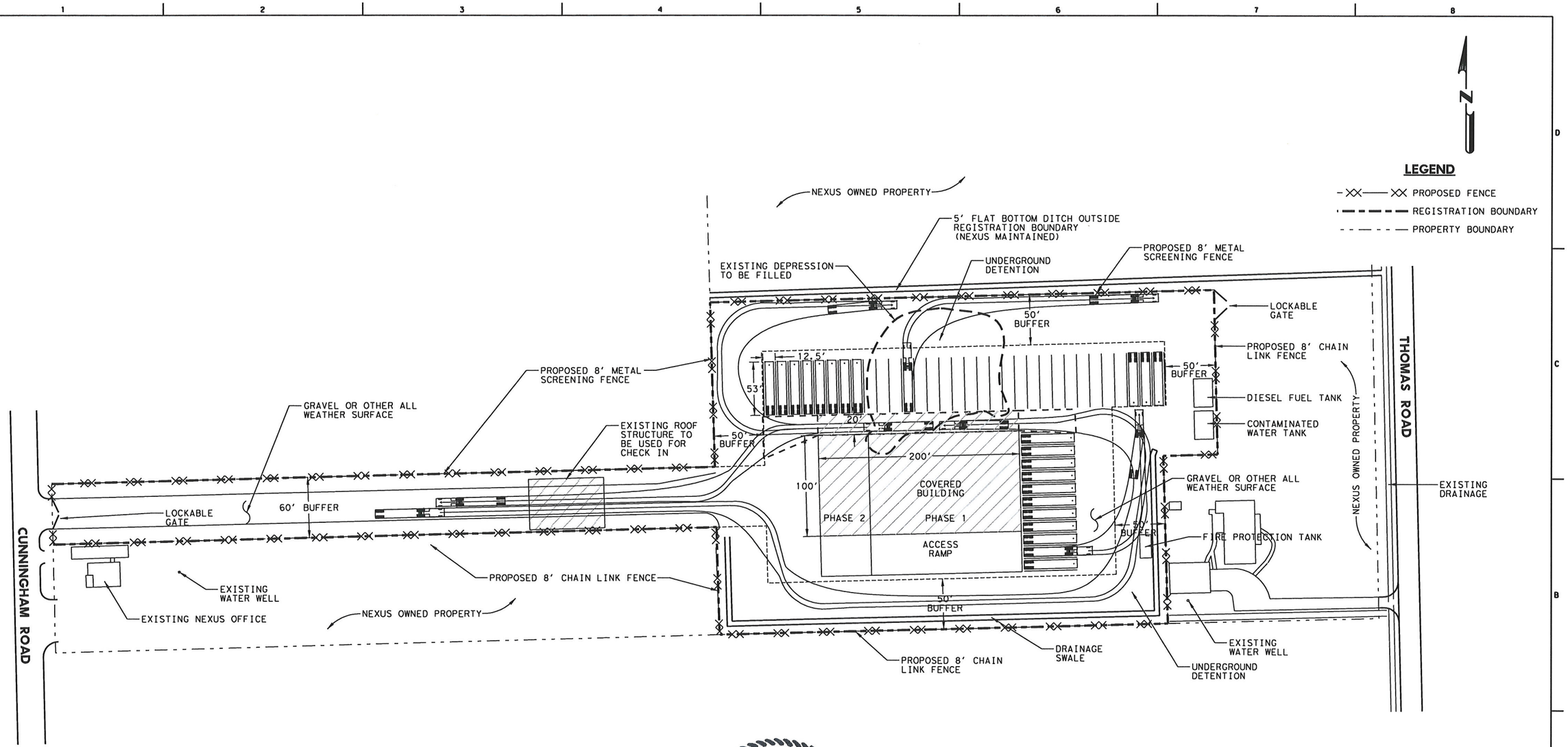
HARRIS COUNTY, TEXAS

GENERAL DETAILS
CROSS SECTIONS

FILENAME N_GD04.dgn
SCALE

SHEET
PART III
FIGURE 8



NOTES:

1. PROPERTY ADDRESS
   6124 CUNNINGHAM ROAD
   6131 THOMAS ROAD
2. CONCEPTUAL TRAFFIC FLOW SHOWN WITH ACTUAL TRUCK TURNING RADII TO DETERMINE BUILDING AND OTHER SITE FEATURES.
3. ALL TRUCK TRAFFIC WILL ENTER/EXIT CUNNINGHAM ROAD. ACCESS FROM THOMAS ROAD LIMITED TO ADMINISTRATIVE AND EMERGENCY.
4. STORAGE AREA IS SUFFICIENT FOR 43 125 C.Y. TRANSFER TRAILERS.

STATE OF TEXAS
JOEL B. MILLER
103847
LICENSED
PROFESSIONAL ENGINEER
10.27.11

DATE: 10/26/2011
TIME: 1:05:14 PM
USER: rcox
FILE: Nexus*01sposal\Nexus*TS*Registration\13.00*CAD\Sheet Files
PLTDRVER:11X17LASER*BW*PDF.plt
PENTABLE:NEW HDR*ERM.TBl

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PROJECT NUMBER	142132

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10/26/2011

NEXUS CONTINUUM, LLC.
HARRIS COUNTY, TEXAS

TRAFFIC FLOW DIAGRAM

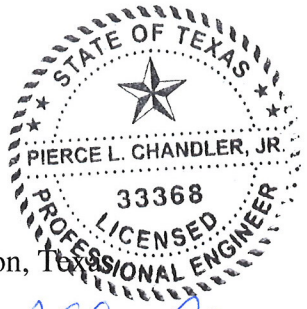
0 50' 100'

FILENAME	N_TFD04.dgn
SCALE	

SHEET
PART III
FIGURE 9

Attachment A – Surface Water Drainage Report

Pierce L. Chandler, Jr., P.E.



Pierce L Chandler Jr.
October 10, 2011
Pages 1-23

DESIGN MEMORANDUM TO: Michael W. Oden, P.E.
SUBJECT: Surface Water Drainage Report
PROJECT: Nexus Continuum Material Recovery & Transfer Station Facility, Houston, Texas
DATE: October 10, 2011
PAGES: 23

PURPOSE AND SCOPE

This design memorandum was prepared to demonstrate compliance with the requirements of **30 TAC §330.303 – Surface Water Drainage for Municipal Solid Waste Facilities and 30 TAC §330.63(c) – Facility Surface Water Drainage Report.** This design memorandum is provided in support of the application by Nexus Continuum for registration of their proposed material recovery and transfer station facility ("Nexus Facility") as a Type V Transfer Station that recycles more than 10% of the incoming waste stream.

PROPERTY DESCRIPTION

The Nexus Facility will occupy a narrow strip of land between Cunningham Road and Thomas Road. The physical location of the Nexus Facility is shown on Part II, Figure II – Facility Layout. Of the approximately 2-1/2 acres of property owned by Nexus Continuum along Cunningham Road, a 60-foot by 660-foot corridor (approximately 0.91 acres) is proposed as part of the Nexus Facility. This narrow strip will be referred to as the "western tract." Of the 5 acres of Nexus-owned property along Thomas Road, approximately 3.6 acres is proposed to be included as part of the Nexus Facility and will be referred to as the "eastern tract." The total registration boundary will encompass 4.51 acres.

SUMMARY

The Nexus Facility will be constructed, maintained, and operated to manage run-on and runoff during the peak discharge of a 25-year rainfall event. The Nexus Facility will prevent the off-site discharge of waste and feed-stock material through a combination of constructed features and operating procedures:

- providing concrete flooring / pavement under all tipping, processing and storage areas
- providing a roof over tipping, processing and interior storage areas to minimize the potential to generate "contaminated water"
- providing constructed features to control run-on and run-off

The Nexus Facility will operate under a TPDES General Permit for storm water discharges. A Storm Water Pollution Prevention Plan ("SWPPP") will be prepared for the facility and will be updated as necessary to reflect site modifications proposed by Nexus.

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The area is characterized by relatively flat relief with a general pattern of drainage to the south. The drainage is split halfway between the two roads. Prevailing hydrologic conditions are industrial development along Cunningham Road and improved pasture/ residential development along Thomas Road. The Nexus Facility proposes "redevelopment" of their western tract along Cunningham Road and "in-fill development" of their eastern tract along Thomas Road that will increase the impervious cover. Development plans call for routing storm-water runoff to existing ditches along Cunningham and Thomas Roads. The existing sheet flow conditions across both the eastern and western tracts will be eliminated by the proposed development. No change in drainage areas or patterns is proposed as part of the development.

Drainage calculations were made for existing conditions and the proposed development so that effects of development could be evaluated. Peak discharge was calculated for both 25-year and 100-year storms using TxDOT and City of Houston Rational Method as well as the NRCS TR-55 Method. The use of multiple methods was to comply with the separate requirements of TCEQ and City of Houston. In addition, such use provides a higher level of confidence in the calculated information.

TCEQ-required Rational Method calculations show that post-development peak discharge increases for the eastern (Thomas Road) drainage subarea. This reflects the effect of development on a relatively undeveloped drainage area. The western (Cunningham Road) drainage subarea discharge is relatively unaffected due to the existing development.

Storm runoff volume and the effects of Houston-required storm water detention were calculated using NRCS TR-55 methods. Only slight increases (3 to 5 %) in runoff volume occurred in the eastern drainage subarea. Increases from the western drainage subarea were negligible (0.3 to 0.4 %). Without any correction for detention, TR-55 method calculations show a significant decrease in peak discharge. City-of-Houston-required detention within the facility decreased peak discharge even further. It should be noted that the proposed diversion of run-on acts as *de facto* detention by increasing time of concentration and consequently decreasing peak discharge.

NEXUS's proposed development will not have any adverse impact on surface water drainage. A comparison of the proposed NEXUS Facility "developed conditions" with existing conditions illustrates the minimal impact to drainage:

- No changes in drainage area or patterns.
- No significant changes in runoff volumes.
- Reduced peak discharges

The design of the Nexus Facility complies with the requirements of **30 TAC 330.303 – Surface Water Drainage for Municipal Solid Waste Facilities**.

GENERAL SURFACE CONDITIONS

Pre-development (natural) drainage conditions

Typical of the Gulf Coastal Prairie physiographic region, the pre-development drainage condition was a relatively flat and poorly-drained, featureless plain that sloped gently south and/or southeast toward the Gulf. Slopes were in the range of 0.3 to 0.35 % in the area of the Nexus Facility. Prevailing soil associations in the area are discussed in detail in **Part II – Attachment B: Soil Information.** Relevant hydrologic information for these soils is summarized in the following table:

Table 1 – Hydrologic Soil Groups

Map Unit Symbol	Map Unit Name	Hydrologic Soil Group
Ad	Addicks Loam	B/D
Ge	Gessner Loam	B/D
Gs	Gessner Complex	B/D
Kf	Katy Fine Sandy Loam	B

If a soil is assigned to a dual Hydrologic Soil Group, e.g., B/D in the above Table, the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

The distribution of these soils is mapped in the **Soil Map** in **Part II – Attachment B: Soil Information.** The east tract and the eastern ½ of the west tract are mapped in the Katy Fine Sandy Loam and the western ½ of the west tract is mapped in the Gessner Loam; however, the area is poorly drained and a Hydrologic Soil Group D is appropriate for these soils and the soils mapped in the surrounding area. In addition, the selection of Hydrologic Soil Group D conditions is conservative for drainage calculations since it maximizes runoff and eliminates any questions about soil mapping errors

Existing drainage conditions

The western tract along Cunningham Road was previously developed for industrial use and most of the area has an improved surface for trafficability, i.e., relatively impervious areas from a hydrologic standpoint. The Nexus property along Thomas Road is relatively undeveloped with only a small, single-family residential structure and detached garage and associated driveway/parking areas; however, the residential development is outside the proposed "eastern tract" boundaries.

Based on **Part II, Figure 4 – Aerial Photograph**, upgradient hydrologic conditions are industrial development along Cunningham Road and improved pasture/ residential development along Thomas Road. **Part II, Figure 3 – General Topographic Map** shows the general drainage pattern is to the south and southeast. As shown on the attached **Drainage Area Map**, run-on to the Nexus property appears to be predominantly sheet flow along the northern boundary with shallow concentrated flow in the road-side ditches along Cunningham and Thomas Roads. Based on mapped information, run-on is generated from an area bounded by

Cunningham and Thomas Roads and extending north approximately 900 feet to a slight drainage divide (drainage north of the drainage divide is routed to a constructed drainage channel tied in to a regional drainage system). The resulting up-gradient area is approximately 27.3 acres. The eastern half of the area is relatively undeveloped; however, industrial development predominates in the western half. Consequently, higher amounts of run-on would be expected for the western tract.

Runoff from the Nexus property is also generally sheet flow across the southern boundary with shallow concentrated flow in the road-side ditches along Cunningham and Thomas Roads and also into a drainage swale midway between Cunningham and Thomas Roads (Miguel A. Gonzalez property, see **Part I, Figure 3 – Land Ownership Map**).

Proposed In-Fill Development and/or Redevelopment

The Nexus Facility proposes "redevelopment" of the western tract and "in-fill development" of the eastern tract that will increase the impervious cover. Development plans call for routing storm-water runoff from the facility to existing roadside ditches along Cunningham and Thomas Roads.

The existing sheet flow conditions across both the eastern and western tracts will be eliminated by the proposed development. Run-on to the Nexus Facility will be intercepted by constructed ditches and/or swales and routed to the roadside ditches along Cunningham and Thomas Roads. City of Houston detention requirements have also been incorporated.

DRAINAGE CALCULATIONS – RATIONAL METHOD FOR PEAK DISCHARGE

Rational Method – Runoff Coefficients

Existing eastern drainage subarea. As noted above, existing soils are can be conservatively assumed to be in Hydrologic Soil Group D. The appropriate Runoff Coefficients, C, were obtained using both TxDOT[1] and City of Houston[2] references. In the TxDOT *Hydraulic Design Manual*, C can be estimated using two different procedures: (1) For "residential suburban" areas, C is in the range of 0.35 to 0.40[3]; and (2) For "rural" areas, TxDOT has a cumulative procedure[4] for determining the Runoff Coefficient, $C = C_r + C_i + C_v + C_s$:

- Relief , $C_r = 0.08$ for flat slopes
- Soil Infiltration, $C_i = 0.12$ for relatively impermeable clay
- Vegetal Cover, $C_v = 0.06$ for good vegetal cover
- Surface, $C_s = 0.06$ for normal surface conditions

The resulting runoff coefficient, $C = C_r + C_i + C_v + C_s = 0.32$.

Based on the two TxDOT approaches, a C = 0.35 is reasonable. It should also be noted that the listed TxDOT runoff coefficients are for low-frequency storms. For a 25-year storm, the runoff coefficients from the TxDOT Tables should be increased by 10% and for a 100-year storm increased by 25%. Alternatively, using the City of Houston requirements[5], C = 0.35 for "residential districts w/ lots more than ½ acres."

Existing western drainage subarea. For the existing industrially-developed western half of the drainage area along Cunningham Road, i.e., "urban districts; industrial", the corresponding Runoff Coefficient, C, was obtained using both TxDOT[6] and City of Houston[7] references. In the TxDOT *Hydraulic Design Manual*, C can be estimated using two different procedures: (1) For "industrial" areas, C is in the range of 0.30 to 0.90[8]; and (2) For "rural" areas, TxDOT has a cumulative procedure[9] for determining the Runoff Coefficient, $C = C_r + C_i + C_v + C_s$. For the western drainage area:

- Relief , $C_r = 0.08$ for flat slopes
- Soil Infiltration, $C_i = 0.16$ for relatively impermeable condition

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[1] *Hydraulic Design Manual,* TxDOT, 2009
[2] *Stormwater Design Requirements,* City of Houston, 2009
[3] *Runoff Coefficients for Urban Watersheds, Hydraulic Design Manual,* TxDOT, 2009
[4] *Runoff Coefficients for Rural Watersheds, Hydraulic Design Manual,* TxDOT, 2009
[5] *Stormwater Design Requirements, §9.05B.3.a.* ,City of Houston, 2009
[6] *Hydraulic Design Manual,* TxDOT, 2009
[7] *Stormwater Design Requirements,* City of Houston, 2009
[8] *Runoff Coefficients for Urban Watersheds, Hydraulic Design Manual,* TxDOT, 2009
[9] *Runoff Coefficients for Rural Watersheds, Hydraulic Design Manual,* TxDOT, 2009

- Vegetal Cover, $C_v = 0.16$ for bare vegetal cover
- Surface, $C_s = 0.10$ for well-drained surface conditions

The resulting runoff coefficient, $C = C_r + C_i + C_v + C_s = 0.50$. Based on the two approaches, an average C = 0.60 is reasonable. It should also be noted that the listed runoff coefficients are for low-frequency storms. For a 25-year storm, the runoff coefficients from the TxDOT Tables should be increased by 10% and for a 100-year storm increased by 25%. The City of Houston[10] provides C = 0.65 for "industrial districts – light areas."

Proposed Nexus Facility. For the proposed Nexus Facility, almost the entire area will be constructed with impervious cover – either pavement or roof. The corresponding C would be 0.60 to 0.90 (TxDOT, 2009) and/or 0.75 to 0.8 (City of Houston, 2009). For these calculations, an average C = 0.75 will be used for TxDOT calculations and an average C= 0.78 for City of Houston calculations. Note that runoff from the proposed 3.6-acre eastern tract of the facility will be combined with runoff from the remainder of the 5-acre Nexus property along Thomas Road. The remaining 1.4 acres is existing residential-type development with a C = 0.35 regardless of method. For the entire 5-acre property, a weighted C of 0.64 (TxDOT) or 0.66 (City of Houston) will be used.

The proposed Nexus Continuum Facility will result in the entire eastern drainage subarea flow being collected and discharged into the Thomas Road ditch at the southeast corner of the Nexus property. Similarly, the entire western drainage subarea flow will be collected and discharged into the Cunningham Road ditch at the southwest corner of the entrance to the facility.

Rational Method – Time of Concentration

TxDOT methodology. Time of concentration, t_c, is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. As noted previously, run-on appears to consist mainly of sheet flow with shallow concentrated flow in the roadside ditches associated with Cunningham and Thomas Roads.

Velocity associated with overland or sheet flow will control time of concentration for the eastern half of the drainage area (eastern subarea) For run-on, typical path length is approximately 900 feet at a slope of approximately 0.3%. Using TxDOT Figure 5-4[11] a limiting velocity of 0.5 feet per second is obtained corresponding to the lower chart value of 0.5% slopes and "short grass pasture." A time of concentration of 1,800 seconds or 30 minutes is subsequently calculated. For existing runoff conditions from the eastern tract of the Nexus property, the 330-foot path length across the property would increase the total path length to approximately 1,230 feet and t_c would increase to 41 minutes. For in-fill development conditions, both run-on and on-site flows

[10] *Stormwater Design Requirements, §9.05B.3.a.*, City of Houston, 2009
[11] *Velocities for Upland Method of Estimating Time of Concentration, Hydraulic Design Manual,* TxDOT, 2009

will be concentrated and redirected to Thomas Road. Segment length will approach 660 feet at grades of approximately 0.3 %. Velocity will increase to 1.25 feet per second[12] (limit velocity for 0.5 % slope and "paved area – sheet flow & shallow gutter flow") and the total time of travel along this segment would be 8.8 minutes resulting in a time of concentration of 38.8 minutes.

For the upgradient western subarea, the existing industrialization will result in a flow velocity of approximately 1.25 feet per second (limit velocity for 0.5 % slope and "paved area – sheet flow & shallow gutter flow"). As for the eastern area, run-on path length is approximately 900 feet at grades of approximately 0.3%. Time of concentration, t_c = 720 seconds or 12 minutes is calculated. The additional travel time over the narrow (50 feet) western tract of Nexus will increase t_c to 12.7 minutes. Redevelopment will redirect flow to Cunningham Road. Maximum length of the segment is 660 feet at a slope of 0.3%. This segment will add 8.8 minutes to the 12-minute off-site travel time resulting in a 20.8 minute time of concentration. Times of concentration for the various conditions are summarized in the following table:

Table 2 – Time of Concentration (TxDOT Method)

Condition	Area (acres)	Time of Concentration,, t_c (minutes)
east side run-on area (existing)	13.65	30
east side runoff subarea (existing)	18.65	41
east side run-on area (proposed)	13.65	38.8
east side facility runoff area (proposed)	3.6	8.8*
total east Nexus property runoff (facility + existing)	5.0	8.8*
total eastern drainage subarea discharge (proposed)	18.65	43.2
west side run-on area (existing)	13.65	12
west side runoff subarea (existing)	14.56	12.7
west side run-on area (proposed)	13.65	20.8
west side facility runoff area (proposed)	0.91	8.8*
total western drainage subarea discharge (proposed)	14.56	21.5

***Note that TxDOT procedures set a minimum time of concentration of 10 minutes.**

It should be noted that the times of concentration given in the above table are less than actual because of the 0.5 % slope limitations of the TxDOT methodology relative to the actual 0.3% prevailing slopes over the drainage area. As a consequence, rainfall intensities and peak discharges calculated from the above times of concentration will be conservatively overestimated.

City of Houston Methodology. Alternatively, time of concentration (in minutes) can be calculated using the equation[13]:

$$t_c = 10 \times (\text{area})^{0.1761} + 15$$

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[12] *Velocities for Upland Method of Estimating Time of Concentration, Hydraulic Design Manual,* TxDOT, 2009
[13] *Stormwater Design Requirements, §9.05B.3.b.* , City of Houston, 2009

where:

area = subarea of watershed (acres)

Calculations of t_c, based on application of that equation to the various drainage areas and/or subareas, are summarized in the following table:

Table 3 – Time of Concentration (City of Houston Method)

Condition	Area (acres)	Time of Concentration, t_c (minutes)
east side run-on area (existing & proposed)	13.65	30.85
east side runoff subarea (existing)	18.65	31.74
east side facility runoff area (proposed)	3.6	27.53
total east Nexus property runoff (facility + existing)	5	28.28
total eastern drainage subarea discharge (proposed)	18.65	31.74
west side run-on area (existing & proposed)	13.65	30.85
west side runoff subarea (existing)	14.56	31.03
west side facility runoff area (proposed)	0.91	24.84
total western drainage subarea discharge (proposed)	14.56	31.03

Based on the above table results, it does not appear that time of concentration is particularly sensitive to area. Note also that t_c is limited to a minimum value of 15 minutes in the City of Houston methodology.

Rational Method – Rainfall Intensity

TxDOT methodology for rainfall intensity. Drainage calculations for peak discharge were performed in general accordance with the Rational Methodology detailed in TxDOT's *Hydraulic Design Manual.*[14] The Rational Method was used because the drainage areas are much less than 200 acres.

Rainfall intensity for use in the TxDOT rational method is based on the time of concentration for runoff to travel from the most hydraulically remote point of a given watershed and is calculated from the equation:

$$\mathbf{I} = b / (t_c + d)^e$$

where:

t_c = time of concentration in minutes (*limited to a minimum of 10 minutes in TxDOT procedures*)

[14] *Hydraulic Design Manual*, TxDOT, 2009

e, b, d = coefficients for specific frequency rainfall event by county[15] (for the 25-year event for Harris County, e = 0.724, b = 81, and d = 7.7, for the 100-year event for Harris County, e = 0.706, b = 91, d = 7.9).

For existing eastern tract run-on calculations, t_c = 30 minutes using TxDOT methodology as detailed above under **Time of Concentration** – see **Table 2**. For existing eastern tract run-off calculations, t_c would increase to 41 minutes using TxDOT methods. Existing western tract t_c are 12 and 12.7 minutes respectively. The proposed segregation of run-on from eastern facility runoff as part of development results in a run-on time of concentration increased to 38.8 minutes and a run-off time of concentration of 8.8 minutes (note that TxDOT procedures set a minimum time of concentration of 10 minutes). TxDOT rainfall intensity for selected storm events is as follows:

Table 4 – Rainfall Intensity (TxDOT Method)

Condition	Area (acres)	t_c (minutes)	25-year Intensity (inches/hour)	100-year Intensity (inches/hour)
east side run-on area (existing)	13.65	30	5.85	6.99
east side runoff subarea (existing)	18.65	41	4.86	5.84
east side run-on area (proposed)	13.65	38.8	5.03	6.03
east side facility runoff area (proposed)	3.6	10 (8.8 actual)	10.11	11.87
total east property runoff (facility + existing)	5.0	10 (8.8 actual)	10.11	11.87
total eastern drainage subarea discharge (proposed)	18.65	43.2	4.71	5.66
west side run-on area (existing)	13.65	12	9.36	11.02
west side runoff subarea (existing)	14.56	12.7	9.13	10.75
west side run-on area (proposed)	13.65	20.8	7.16	8.51
west side facility runoff area (proposed)	0.91	10 (8.8 actual)	10.11	11.87
total western drainage subarea discharge (proposed)	14.56	21.5	7.04	8.36

City of Houston methodology for rainfall intensity. Houston's *Stormwater Design Requirements*[16] use the same equation as TxDOT for intensity; however, the coefficients are specified differently and time of concentration is not limited to a minimum of 10 minutes. For the 25-year storm event, the coefficients are: b = 115.9, d = 21.2, and e = 0.7808. For the 100-year storm event, the coefficients are: b = 125.4, d = 21.8, and e = 0.7500. Using times of concentration (City of Houston Method) provided in Table 3, rainfall intensities for both storm events are given in the following table:

[15] *TP-40*, U.S. Department of Commerce, 1961
[16] *Stormwater Design Requirements, Figure 9.1*, City of Houston, 2009

Table 5 – Rainfall Intensity (City of Houston)

Condition	Area (acres)	t_c (minutes)	25-year Intensity (inches/hour)	100-year Intensity (inches/hour)
entire run-on area	27.3	32.9	5.14	6.23
entire runoff area	33.21	33.53	5.09	6.18
east side run-on area (existing & proposed)	13.65	30.85	5.30	6.42
east side runoff subarea (existing)	18.65	31.74	5.23	6.34
east side facility runoff area (proposed)	3.6	27.53	5.58	6.74
total east property runoff (facility + existing)	5	28.28	5.51	6.66
total eastern drainage subarea discharge (proposed)	18.65	31.74	5.23	6.34
west side run-on area (existing & proposed)	13.65	30.85	5.30	6.42
west side runoff subarea (existing)	14.56	31.03	5.28	6.40
west side facility runoff area (proposed)	0.91	24.84	5.83	7.03
total western drainage subarea discharge (proposed)	14.56	31.03	5.28	6.40

The TxDOT and Houston rainfall intensities are significantly different – TxDOT being higher – due to the major differences in calculated time of concentration, t_c. TxDOT time of concentrations are based on hydraulic path and Houston time of concentrations are based on drainage area as noted in **Tables 2 and 3**.

Rational Method – Peak Discharge

The Rational Method Equation is expressed as:

Q = CIA

where:

Q = maximum rate of runoff, i.e., discharge (cubic feet per second or cfs)
C = runoff coefficient (dimensionless)
I = average rainfall intensity (inches per hour or in./hr.)
A = drainage area (acres or Ac.)

The peak discharge for the 25-year storm is summarized in the following table:

Table 6 – 25-year, 24-hour Storm Peak Discharge (Rational Method)

Condition	Area (acres)	TxDOT Runoff Coefficient*	TxDOT Intensity (in/hr)	TxDOT Discharge (cfs)	Houston Runoff Coefficient	Houston Intensity (in/hr)	Houston Discharge (cfs)
Run-on to East Tract (existing)	13.65	0.35 x 1.1	5.85	30.74	0.35	5.30	25.32
Runoff from East Tract (existing)	18.65	0.35 x 1.1	4.86	34.90	0.35	5.23	34.14
Run-on to East Tract (proposed diversion)	13.65	0.35 x 1.1	5.03	26.43	0.35	5.30	25.32
Runoff from East Facility only (proposed)	3.6	0.75 (avg) x 1.1	10.11	30.03	0.78 (avg)	5.58	15.67
Total east Nexus property runoff (facility + existing)	5.0	0.64 (wt) x 1.1	10.11	35.59	0.66 (wt)	5.51	18.18
Total eastern drainage subarea discharge (proposed)	18.65	0.43 (wt) x 1.1	4.71	41.55	0.43 (wt)	5.23	41.94
Run-on to West Tract (existing)	13.65	0.60 x 1.1	9.36	84.32	0.65	5.30	47.02
Runoff from West Tract (existing)	14.56	0.60 x 1.1	9.13	87.74	0.65	5.28	49.97
Run-on to West Tract (proposed diversion)	13.65	0.60 x 1.1	7.16	64.50	0.65	5.30	47.02
Runoff from West Facility only (proposed)	0.91	0.75 (avg) x 1.1	10.11	7.59	0.78 (avg)	5.83	4.14
Total western drainage subarea discharge (proposed)	14.56	0.61 (wt) x 1.1	7.04	68.78	0.66 (wt)	5.28	50.74

***Note: TxDOT runoff coefficients increased by 10% per TxDOT procedure for 25-year storm calculations. Abbreviations "avg" and "wt" refer to average methodology and area-weighted respectively.**

Based on the comparison of proposed development to existing conditions, the above calculations indicate that development will have the following impacts on Rational Method 25-year, 24-hour storm peak discharge from the site:

- For the eastern drainage subarea, TxDOT and Houston methodologies estimate comparable peak discharges.
- For the eastern drainage subarea, in-fill development of the eastern tract, diversion of run-on, and collection of flow to a single discharge point will increase rational method peak discharge compared to existing sheet-flow discharge; however, the effects of detention are not included.
- For the western drainage subarea, TxDOT and Houston methodologies estimate considerably different peak discharges. This is a consequence of the differences in estimating time of concentration.
- For the western drainage subarea, in-fill development of the western tract and diversion of run-on will significantly decrease peak discharge based on TxDOT methodology.
- For the western drainage subarea, in-fill development of the western tract, diversion of run-on, and collection of flow to a single discharge point has no impact on peak discharge based on City of Houston methodology

Although TCEQ requirements for transfer stations are based on 25-year storms, the peak discharge for the 100-year storm was also calculated for comparison purposes. The calculations are summarized in the following table:

Table 7 – 100-year, 24-hour Storm Peak Discharge (Rational Method)

Condition	Area (acres)	TxDOT Runoff Coefficient*	TxDOT Intensity (in/hr)	TxDOT Discharge (cfs)	Houston Runoff Coefficient	Houston Intensity (in/hr)	Houston Discharge (cfs)
Run-on to East Tract (existing)	13.65	0.35 x 1.25	6.99	41.74	0.35	6.42	30.67
Runoff from East Tract (existing)	18.65	0.35 x 1.25	5.84	47.65	0.35	6.34	41.38
Run-on to East Tract (proposed diversion)	13.65	0.35 x 1.25	6.03	36.01	0.35	6.42	30.67
Runoff from East Facility only (proposed)	3.6	0.75 (avg) x 1.25	11.87	40.06	0.78 (avg)	6.74	18.93
Total east Nexus property runoff (facility + existing)	5.0	0.64 (wt) x 1.25	11.87	47.48	0.66 (wt)	6.66	21.98
total eastern drainage subarea discharge (proposed)	18.65	0.43 (wt) x 1.25	5.66	56.74	0.43 (wt)	6.34	50.84
Run-on to West Tract (existing)	13.65	0.60 x 1.25	11.02	112.82	0.65	6.42	56.96
Runoff from West Tract (existing)	14.56	0.60 x 1.25	10.75	117.39	0.65	6.40	60.57
Run-on to West Tract (proposed diversion)	13.65	0.60 x 1.25	8.51	87.12	0.65	6.42	56.96
Runoff from West Facility only (proposed)	0.91	0.75 (avg) x 1.25	11.87	10.13	0.78 (avg)	7.03	4.99
Total western drainage subarea discharge (proposed)	14.56	0.61 (wt) x 1.25	8.36	92.81	0.66 (wt)	6.40	61.50

***Note: TxDOT runoff coefficients increased by 25% per TxDOT procedure for 100-year storm calculations. Abbreviations "avg" and "wt" refer to average methodology and area-weighted respectively.**

Based on the comparison of proposed development to existing conditions, the above calculations indicate that development will have the following impacts on Rational Method 100-year, 24-hour storm peak discharge from the site:

- For the eastern drainage subarea, TxDOT and Houston methodologies estimate differing peak discharges. Much of the difference can be attributed to the 1.25 factor applied to the runoff coefficient.
- For the eastern drainage subarea, in-fill development of the eastern tract, diversion of run-on, and collection of flow to a single discharge point will increase rational method peak discharge compared to existing sheet-flow discharge; however, the effects of detention are not included.
- For the western drainage subarea, TxDOT and Houston methodologies estimate considerably different peak discharges. This is a consequence of the differences in estimating time of concentration.
- For the western drainage subarea, in-fill development of the western tract and diversion of run-on will significantly decrease peak discharge based on TxDOT methodology.
- For the western drainage subarea, in-fill development of the western tract, diversion of run-on, and collection of flow to a single discharge point has no impact on peak discharge based on City of Houston methodology

DRAINAGE CALCULATIONS – TR-55 METHODS FOR RUNOFF VOLUME AND PEAK DISCHARGE

TR-55 – Runoff Curve Numbers

Existing eastern drainage subarea. As noted above, existing soils are can be conservatively assumed to be in Hydrologic Soil Group D. For the relatively undeveloped half of the drainage area along Thomas Road, i.e. "open space", a Runoff Curve Number, CN, of 84 is appropriate.[17]

Existing western drainage subarea. For the existing industrially-developed western half of the drainage area along Cunningham Road, i.e., "urban districts; industrial", a Runoff Curve Number, CN, of 93 is appropriate.[18]

Proposed Nexus Facility. For the proposed Nexus Facility, almost the entire area will be constructed with impervious cover – either pavement or roof. The corresponding CN would be 98.

TR-55 – Time of Concentration

TR-55 methods of determining time of concentration require different assumptions and methodology from the Rational Method. TR-55 generally allows sheet flow up to a maximum distance of 300 feet and "shallow concentrated flow" thereafter.[19] Sheet flow is only applicable to that portion of the eastern drainage subarea upgradient of the Nexus facility.

Existing eastern drainage subarea. For the sheet flow segment, travel time, T_t can be calculated from

$$T_t = \frac{0.007\ (nL)^{0.8}}{(P_2)^{0.5}\ (s)^{0.4}}$$

where:

T_t = travel time (hours or hr)
n = Manning's roughness coefficient
L = flow length (feet or ft)
P_2 = 2-year, 24-hour rainfall (inches or in)
s = slope of hydraulic grade line (land slope, feet/feet)

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[17] *TR-55, Table 2-2a – Runoff curve numbers for urban areas,* NRCS, 1986
[18] *TR-55, Table 2-2a – Runoff curve numbers for urban areas,* NRCS, 1986
[19] *TR-55, Chapter 3 – Time of Concentration and Travel Time*, NRCS, 1986

The 2-year, 24-hour rainfall for Harris County is about 5 inches.[20] As previously noted under **General Surface Conditions**, slopes range from 0.3 to 0.35 %. For time of travel calculations, an average slope of 0.325 % (0.00325 feet/feet) will be assumed. Manning's n for the prevailing "short grass prairie" conditions in the eastern drainage subarea is 0.15. The resulting time of travel for 300 feet of sheet flow is 0.65077 hours.

Time of travel for the "shallow concentrated flow" segment can be calculated from the average flow length of 600 feet and the equation for average flow velocity for unpaved areas:

$$V = 16.1345\ (s)^{0.5}$$

where:

V = average velocity (feet per second or ft/sec)
s = slope of hydraulic grade line (land slope, feet/feet)

Based on an average slope of 0.325 % (0.00325 feet/feet), average velocity is 0.92 feet per second. Time of travel over 600 feet at that velocity is 652 seconds or 0.18116 hours.

The run-on time of concentration, T_c is simply the sum of the times of travel = 0.65077 + 0.18116 = 0.83193 hours (49.92 minutes).

The run-off time of concentration (for existing conditions) will include an additional 330 feet of unpaved shallow concentrated flow at the same average slope. The time of travel for this segment will be 359 seconds or 0.09964 hours. The runoff time of concentration, T_c is simply the sum of the times of travel = 0.65077 + 0.18116 + 0.09964 = 0.93157 hours (55.89 minutes).

Existing western drainage subarea. The western drainage subarea will be almost exclusively "shallow concentrated flow" over mostly paved areas. The equation for average flow velocity for paved areas:

$$V = 20.3282\ (s)^{0.5}$$

where:

V = average velocity (feet per second or ft/sec)
s = slope of hydraulic grade line (land slope, feet/feet)

Based on an average slope of 0.325 % (0.00325 feet/feet), average velocity is 1.16 feet per second. Time of travel over 900 feet at that velocity is 776 seconds or 0.21556 hours (12.93 minutes). Since there is only a single path segment, the run-on $T_c = T_t$ = 0.21556 hours (12.93

[20] *TP-40*, U.S. Department of Commerce, 1961

minutes). The western Nexus property will only add a few feet to the flow path and the run-on T_c will conservatively represent T_c for existing runoff conditions.

Proposed eastern drainage subarea. Proposed development of the eastern tract will segregate run-on from run-off generated within the facility. Run-on will be diverted via a constructed ditch along the north side of the facility. Facility runoff will be discharged through a constructed ditch or swale on-site. Both ditches will be approximately 660 feet in length at an average grade of 0.3 %. Again using

$$V = 20.3282\ (s)^{0.5}$$

where:

V = average velocity (feet per second or ft/sec)
s = slope of hydraulic grade line (land slope, feet/feet)

Based on an average slope of 0.3 % (0.003 feet/feet), average velocity is 1.1134 feet per second. Time of travel over 660 feet at that velocity is 593 seconds or 0.16472 hours. The runoff time of concentration, T_c for the diverted run-on will be 0.83193 hours + 0.16472 hours = 0.99665 hours. Facility runoff will travel 660 feet at that same velocity with a resulting travel time or time of concentration of 593 seconds or 0.16472 hours.

It should be noted that drainage from the remaining 1.4 acres of the Nexus-owned property along Thomas Road will combine with the drainage from the proposed facility for a total contributing watershed of 5 acres for run-off.

All of the flow from the eastern drainage subarea will ultimately be routed to a common discharge point in the Thomas Road ditch at the southeast corner of the Nexus property. For the entire subarea, travel time for an additional 330 feet to the southeast corner of the Nexus property at an average velocity of 1.16 feet per second (0.325 % average grade) will be 0.079023 hours (4.74 minutes) for a total time of concentration = 0.99665 + 0.078023 = 1.075673 hours.

Proposed western drainage subarea. Proposed development of the western tract will segregate run-on from run-off generated within the facility. Run-on will be diverted via a constructed ditch or swale along the north side of the facility entrance road. Facility runoff will be collected in a ditch or swale along the south side of the entrance road. Both ditches will be approximately 660 feet in length at an average grade of 0.3 %. Again using

$$V = 20.3282\ (s)^{0.5}$$

where:

V = average velocity (feet per second or ft/sec)

s = slope of hydraulic grade line (land slope, feet/feet)

Based on an average slope of 0.3 % (0.003 feet/feet), average velocity is 1.1134 feet per second. Time of travel over 660 feet at that velocity is 593 seconds or 0.16472 hours. The runoff time of concentration, T_c for the diverted run-on will be 0.21556 hours + 0.16472 hours = 0.38028 hours. The facility run-off time of concentration for the western part of the proposed Nexus Facility (access road) will be 0.16472 hours.

All of the flow from the western drainage subarea will ultimately be routed to a common discharge point in the Cunningham Road ditch at the southwest corner of the facility entrance.

TR-55 Method for Runoff Volume Estimation.

Procedures given in *TR-55*[21] can be used to generate storm runoff volumes. For a given rainfall event, the direct runoff can be calculated from equations in TR-55:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)} \qquad \text{(Equation 2-3)}$$

$$S = \frac{1000}{CN} - 10 \qquad \text{(Equation 2-4)}$$

where:

Q = runoff (inches)
P = rainfall (inches)
S = potential maximum retention after runoff begins (inches)

For the NEXUS site, the 25-year, 24-hour rainfall is approximately 9.5 inches[22]. For this rainfall amount, runoff volume calculations for each drainage subarea and condition are summarized in the following table:

[21] TR-55 – *Urban Hydrology for Small Watersheds* , NRCS, 1986
[22] *TP-40*, U.S. Department of Commerce, 1961

Table 8 – 25-year, 24-hour Storm Runoff (TR-55)

Condition	Area (acres)	Curve Number CN*	Max Retention S	Runoff (inches)	Runoff (Ac-ft)	Proposed Change (Ac-ft)
Run-on to East Tract (existing)	13.65	84	1.90	7.54	8.58	--
Eastern drainage subarea (existing)	18.65	84	1.90	7.54	11.72	--
Diverted run-on from East Tract (proposed)	13.65	84	1.90	7.54	8.58	--
Runoff from East Facility (proposed)	3.6	98	0.204	9.26	2.78	--
Runoff from east Nexus property (facility + existing)	5	94.1 (wt)	0.627	8.79	3.66	--
Total runoff from eastern drainage subarea (proposed)	18.65	86.7 (wt)	1.534	7.88	12.25	0.53
Run-on to West Tract (existing)	13.65	93	0.75	8.65	9.84	--
Western drainage subarea (existing)	14.56	93	0.75	8.65	10.50	--
Diverted run-on from West Tract (proposed)	13.65	93	0.75	8.65	9.84	--
Runoff from West Facility (proposed)	0.91	98	0.204	9.26	0.70	--
Total runoff from western drainage subarea (proposed)	14.56	93.3 (wt)	0.718	8.69	10.54	0.04

* **Abbreviation "wt" refers to area-weighted.**

The above calculations show that the proposed redevelopment will result in minor increases in total runoff volume of 0.53 acre-feet (4.5 %) (eastern subdrainage area) and 0.04 acre-feet (0.4%) (western subdrainage area) without any reliance on stormwater detention or retention. However, it should be noted that the City of Houston has specific detention volume requirements[23] depending on subarea size. For areas less than 1 acre, a detention volume of 0.20 acre-feet per acre of increased impervious cover is required.[24] For areas greater than 1 acre, a detention volume of 0.50 acre-feet per acre of increased impervious cover is required.[25] These detention volumes are based on 100-year storm requirements. For the 3.6-acre east tract, a maximum detention volume of 1.8 acre-feet is required. For the 0.91-acre west tract, a maximum detention volume of 0.182 acre-feet is required. It should be further noted that the required detention is larger than the increase in runoff from either tract.

Although TCEQ requirements for transfer stations are based on 25-year storms, runoff volume calculation for the 100-year storm is necessary for comparison to the City of Houston detention requirements. The 100-year, 24-hour rainfall is approximately 12.5 inches.[26] Runoff volume calculations for the 100-year storm are given in the following table:

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[23] *Stormwater Design Requirements §9.05.H.3.* , City of Houston, 2009
[24] *Stormwater Design Requirements §9.05.H.3.b.* , City of Houston, 2009
[25] *Stormwater Design Requirements §9.05.H.3.c.* , City of Houston, 2009
[26] *TP-40*, U.S. Department of Commerce, 1961

Table 9 – 100-year, 24-hour Storm Runoff (TR-55)

Condition	Area (acres)	Curve Number CN*	Max Retention S	Runoff (inches)	Runoff (Ac-ft)	Proposed Change (Ac-ft)
Run-on to East Tract (existing)	13.65	84	1.90	10.47	11.91	--
Eastern drainage subarea (existing)	18.65	84	1.90	10.47	16.27	--
Diverted run-on from East Tract (proposed)	13.65	84	1.90	10.47	11.91	--
Runoff from East Facility (proposed)	3.6	98	0.204	12.26	3.68	--
Runoff from east Nexus property (facility + existing)	5	94.1 (wt)	0.627	11.78	4.91	--
Total runoff from eastern drainage subarea (proposed)	18.65	86.7 (wt)	1.534	10.83	16.83	0.56
Run-on to West Tract (existing)	13.65	93	0.75	11.64	13.24	--
Western drainage subarea (existing)	14.56	93	0.75	11.64	14.12	--
Diverted run-on from West Tract (proposed)	13.65	93	0.75	11.64	13.24	--
Runoff from West Facility (proposed)	0.91	98	0.204	12.26	0.93	--
Total runoff from western drainage subarea (proposed)	14.56	93.3 (wt)	0.718	11.67	14.16	0.04

* **Abbreviation "wt" refers to area-weighted.**

The above calculations show that the proposed redevelopment will result in minor increases in total runoff of 0.56 acre-feet (3.4 %) (eastern subdrainage area) and 0.04 acre-feet (0.3%) (western subdrainage area) without any reliance on stormwater detention or retention.

TR-55 Method for Peak Discharge

The "Graphical Peak Discharge Method"[27] will be used for estimating peak discharge. For this method, the appropriate rainfall distribution for Harris County is Type III.[28] The peak discharge equation is:

$$q_p = q_u A_m Q F_p$$

where:

q_p = peak discharge (cubic feet per second or cfs)
q_u = unit peak discharge (cubic feet per square mile per inch or csm/in) (Exhibit 4-III)
A_m = drainage area (square miles or mi^2)
Q = runoff (inches or in)
F_p = pond and swamp adjustment factor = 0

[27] *TR-55, Chapter 4 – Graphical Peak Discharge Method* , NRCS, 1986
[28] *TR-55, Figure B-2 – Approximate geographic boundaries for SCS rainfall distributions* , NRCS, 1986

Peak discharge has been calculated for both the 25-year and 100-year storm events using *TR-55* methods. The calculations are summarized in the following tables:

Table 10 – 25-year, 24-hour Storm Peak Discharge (TR-55 Method)

Condition	Area ($miles^2$)	Curve Number CN	I_a (inches)	P (inches)	I_a / P	Tc (hours)	Q (inches)	q_u (csm/in)	q_p (cfs)
Run-on to East Tract (existing)	0.0213	84	0.381	9.5	0.040	0.83	7.54	325	52.20
Eastern drainage subarea (existing)	0.0291	84	0.381	9.5	0.040	0.93	7.54	302	66.26
Diverted run-on from East Tract (proposed)	0.0213	84	0.381	9.5	0.040	1.00	7.54	295	47.38
East Facility (proposed)	0.0056	98	0.0408	9.5	0.0043	0.165	9.26	590	30.60
Runoff from east Nexus property (facility + existing)	0.0078	94.1 (wt)	0.125	9.5	0.0132	0.165	8.79	590	40.45
Total runoff from eastern drainage subarea (proposed)	0.0291	86.7 (wt)	0.3068	9.5	0.0323	1.076	7.88	280	64.21
Run-on to West Tract (existing)	0.0213	93	0.151	9.5	0.016	0.22	8.65	550	101.33
Western drainage subarea (existing)	0.0228	93	0.151	9.5	0.016	0.22	8.65	550	107.04
Diverted run-on from West Tract (proposed)	0.0213	93	0.151	9.5	0.016	0.38	8.65	450	82.91
Runoff from West Facility (proposed)	0.0014	98	.0408	9.5	0.0043	0.165	9.26	590	6.56
Total runoff from western drainage subarea (proposed)	0.0228	93.3 (wt)	0.144	9.5	0.0152	0.38	8.69	450	89.16

Table 11 – 100-year, 24-hour Storm Peak Discharge (TR-55 Method)

Condition	Area (miles^2)	Curve Number CN	I_a (inches)	P (inches)	I_a / P	Tc (hours)	Q (inches)	q_u (csm/in)	q_p (cfs)
Run-on to East Tract (existing)	0.0213	84	0.381	12.5	0.030	0.83	10.47	325	72.48
Eastern drainage subarea (existing)	0.0291	84	0.381	12.5	0.030	0.93	10.47	302	92.01
Diverted run-on from East Tract (proposed)	0.0213	84	0.381	12.5	0.030	1.00	10.47	295	65.79
Runoff from East Facility (proposed)	0.0056	98	0.0408	12.5	0.0033	0.165	12.26	590	40.51
Runoff from east Nexus property (facility + existing)	0.0078	94.1 (wt)	0.125	12.5	0.010	0.165	11.78	590	54.21
Total runoff from eastern drainage subarea (proposed)	0.0291	86.7 (wt)	0.3068	12.5	0.024	1.076	10.83	280	88.24
Run-on to West Tract (existing)	0.0213	93	0.151	12.5	0.012	0.22	11.64	550	136.36
Western drainage subarea (existing)	0.0228	93	0.151	12.5	0.012	0.22	11.64	550	145.96
Diverted run-on from West Tract (proposed)	0.0213	93	0.151	12.5	0.012	0.38	11.64	450	111.57
Runoff from West Facility (proposed)	0.0014	98	.0408	12.5	0.0033	0.165	12.26	590	10.13
Total runoff from western drainage subarea (proposed)	0.0228	93.3 (wt)	0.144	12.5	0.012	0.38	11.67	450	119.73

A comparison of existing to proposed peak discharge (TR-55 methodology) indicates the following:

- Peak discharge for both drainage subareas is reduced by the proposed development without considering any detention.
- The significant reduction in peak discharge from the western drainage subarea is the result of increased time of concentration resulting from diversion.

It should be noted that the City of Houston has specific detention volume requirements[29] depending on subarea size. For areas less than 1 acre, a detention volume of 0.20 acre-feet per acre of increased impervious cover is required.[30] For areas greater than 1 acre, a detention volume of 0.50 acre-feet per acre of increased impervious cover is required.[31] These detention volumes are based on 100-year storm requirements. For the 3.6-acre east tract, a maximum detention volume of 1.8 acre-feet is required. For the 0.91-acre west tract, a maximum detention volume of 0.182 acre-feet is required.

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[29] *Stormwater Design Requirements §9.05.H.3.* , City of Houston, 2009
[30] *Stormwater Design Requirements §9.05.H.3.b.* , City of Houston, 2009
[31] *Stormwater Design Requirements §9.05.H.3.c.* , City of Houston, 2009

From the standpoint of the entire drainage subareas (upgradient areas and on-site areas), the Houston-required detention will have an effect. TR-55 has a procedure for estimating the effect of detention volume on maximum discharge.[32] Using previously calculated information for runoff volume, required detention storage volume, and unadjusted peak discharge and a Type III rainfall distribution, the effect of detention can be calculated.[33] Calculations are summarized in the following table:

Table 12 – Detention Storage Effect On 25-year, 24-hour Peak Discharge (TR-55 Method)

Condition	Runoff Volume (ac-ft)	Detention Storage Volume (ac-ft)	Storage / Runoff Volume Ratio	Outflow/ Inflow Discharge Ratio	Peak Inflow (cfs)	Detention Outflow (cfs)
Run-on to East Tract (existing)	8.58	0	0	≈ 1.0	52.20	N/A
Eastern drainage subarea (existing)	11.72	0	0	≈ 1.0	66.26	N/A
Diverted run-on from East Tract (proposed)	8.58	0	0	≈ 1.0	52.20	47.38*
Runoff from East Facility (proposed)	2.78	1.80	0.6475	< 0.1	30.60	< 3.06
Runoff from east Nexus property (facility + existing)	3.66	1.80	0.4918	0.16	40.45	6.47
Total runoff from eastern drainage subarea (proposed)	12.25	1.80	0.1469	> 0.8	64.21	> 51.37
Run-on to West Tract (existing)	9.84	0	0	≈ 1.0	101.33	N/A
Western drainage subarea (existing)	10.50	0	0	≈ 1.0	107.04	N/A
Diverted run-on from West Tract (proposed)	9.84	0	0	≈ 1.0	101.33	82.91*
Runoff from West Facility (proposed)	0.70	0.182	0.26	0.54	6.56	3.54
Total runoff from western drainage subarea (proposed)	10.54	0.182	0.0173	> 0.8	89.16	> 71.33

***Note also that the proposed diversion of run-on acts as *de facto* detention by increasing time of concentration and consequently decreasing peak discharge.**

[32] *TR-55, Chapter 4 – Storage volume for detention basins*, NRCS, 1986
[33] *TR-55, Figure 6-1 – Approximate detention basin routing for rainfall types I, IA, II, and III*, NRCS, 1986

Table 13 – Detention Storage Effect On 100-year, 24-hour Peak Discharge (TR-55 Method)

Condition	Runoff Volume (ac-ft)	Detention Storage Volume (ac-ft)	Storage / Runoff Volume Ratio	Outflow/ Inflow Discharge Ratio	Peak Inflow (cfs)	Detention Outflow (cfs)
Run-on to East Tract (existing)	11.91	0	0	≈ 1.0	72.48	N/A
Eastern drainage subarea (existing)	16.27	0	0	≈ 1.0	92.01	N/A
Diverted run-on from East Tract (proposed)	11.91	0	0	≈ 1.0	72.48	65.79*
Runoff from East Facility (proposed)	3.68	1.80	0.4891	0.16	40.51	6.48
Runoff from east Nexus property (facility + existing)	4.91	1.80	0.3666	0.31	54.21	16.80
Total runoff from eastern drainage subarea (proposed)	16.83	1.80	0.107	> 0.8	88.24	> 70.59
Run-on to West Tract (existing)	13.24	0	0	≈ 1.0	136.36	N/A
Western drainage subarea (existing)	14.12	0	0	≈ 1.0	145.96	N/A
Diverted run-on from West Tract (proposed)	13.24	0	0	≈ 1.0	136.36	111.57*
Runoff from West Facility (proposed)	0.93	0.182	0.1957	0.73	10.13	7.39
Total runoff from western drainage subarea (proposed)	14.16	0.182	0.0128	> 0.8	119.73	> 95.78

***Note also that the proposed diversion of run-on acts as *de facto* detention by increasing time of concentration and consequently decreasing peak discharge.**

Proposed detention and diversion (segregation) of run-on will significantly reduce peak discharge from the eastern and western portions of the Nexus Facility as well as peak discharge from the eastern and western drainage subareas.

CONCLUSIONS

The proposed Nexus Facility is at the bottom of an approximately 33-acre watershed that is divided between Cunningham and Thomas Roads. The existing eastern (Thomas Road) drainage subarea is primarily improved pasture / residential development. The existing western (Cunningham Road) drainage subarea is primarily industrial development. As a result of these differences in existing conditions between the two drainage subareas, higher discharges and runoff volumes are associated with the western drainage.

Run-on will be diverted to either road (road-side ditch) as part of the development. Run-off generated from the Facility will be routed through City-of-Houston required detention. **No change in drainage areas or patterns is proposed as part of the development.**

TCEQ-required Rational Method calculations show that post-development peak discharge increases for the eastern (Thomas Road) drainage subarea. This reflects the effect of development on a relatively undeveloped drainage area. The western (Cunningham Road)

drainage subarea discharge is relatively unaffected. Regardless, the Rational Method calculations do not allow for the effect of proposed detention.

NRCS TR-55 calculations for runoff volume indicate negligible increases for the western drainage subarea and increases of only a few percent for the eastern drainage subareas. TR-55 calculations show that the proposed facility will reduce peak discharge without considering any detention; however, detention is proposed in accordance with City of Houston requirements. The TR-55 calculations show proposed detention of runoff and diversion (segregation) of run-on will significantly reduce peak discharge from the eastern and western portions of the Nexus Facility as well as peak discharge from the eastern and western drainage subareas.

NEXUS's proposed development will not have an adverse impact on surface water drainage. A comparison of the proposed NEXUS Facility "developed conditions" with existing conditions illustrates the minimal impact to drainage:

- No change in drainage area or patterns.
- No significant changes in runoff volumes.
- Reduced peak discharges

The design of the Nexus Facility complies with the requirements of **30 TAC 330.303 – Surface Water Drainage for Municipal Solid Waste Facilities**.

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ATTACHMENT

11 x 17 **Drainage Area Map**

PETROPARK

REAGAN

CUNNINGHAM

THOMAS

UNNAMED DRAINAGE CHANNEL

OVERLOOK

EXISTING RUN-ON DRAINAGE AREA (APPROX. 27.3 ACRES)

SITE LOCATION

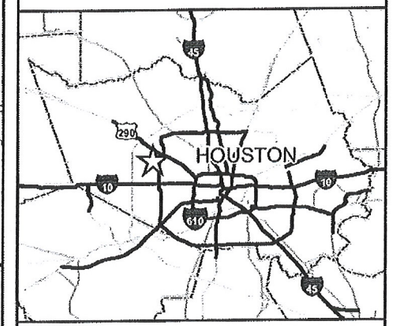
DRAINAGE AREA MAP

NEXUS MATERIAL RECOVERY & TRANSFER STATION

TYPE V MSW REGISTRATION

NEXUS CONTINUUM LLC

HARRIS CO, TX



LEGEND

- REGISTRATION BOUNDARY
- PROPERTY BOUNDARY
- DRAINAGE AREA
- DRAINAGE CHANNEL
- 1-FOOT INDEX CONTOUR
- 1-FOOT INTERMEDIATE CONTOUR

STATE OF TEXAS
PIERCE L. CHANDLER, JR.
33368
LICENSED
PROFESSIONAL ENGINEER

October 19, 2011

SOURCE: 2008, HOUSTON-GALVESTON AREA COUNCIL

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NEXUS CONTINUUM

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