Fill WBZ Trench Design
DEQ Comment and Response Matrix

ID No.	Section Name/ Topic	Section/Table/ Figure No.	Page No.	DEQ Comment	Category	NW Natural Response
1	Model Documentation	General Comment	N/A	Section 4.1 provides a brief overview of the groundwater modelling done to evaluate trenches in the Fill WBZ. Appendix D presents and discusses the modelling work in more detail, including the simulations for each of the combinations of one or two trenches and variations of the lengths and alignments. The Draft LNG Basin Trench Design does not include information regarding modelling assumptions of the model and the potential limitations those assumptions have on the interpretations and conclusions of the various simulations discussed in the document. DEQ requests that NW Natural include a section in Appendix D discussing model assumptions the associated limitations with information regarding, but not limited to the following [see Comments 2, 3, and 4]:	Text modified as requested	Text was added to discuss the model assumptions and their limitations.
2	Model Grid-Spacing	General Comment	N/A	The design document utilizes the site-wide groundwater to assess the hydraulic influence of different combinations of trenches on shallow groundwater capture. The grid-spacing, including the potential influence and/or limitations of spacing on model simulations, should be discussed in the context of the scale of the LNG Basin trench removal action.	Text modified as requested	Text was added to discuss the grid spacing in the context of the scale of the Liquefied Natural Gas (LNG) Basin trench.
3	Selection of Hydraulic Conductivity	General Comment	N/A	Estimates of hydraulic conductivity (K) presented in the submittal appear to be highly variable. In the majority of samples, the HydrogeoSieveXL results for methods that met the criteria showed a consistent bi-modal distribution. The Kruger, Kozeny, Zunker and Zamarin calculation methods typically yielded K-values 10 to 20 times higher than other methods in the suite. Given the distribution of estimates, it's not clear the geometric mean values assigned to the model are representative of the hydraulic conductivity of the Fill WBZ for modelling purposes. DEQ requests that the Appendix D discuss the use of, and uncertainty with using the geometric mean for groundwater modelling in the context of the HydrogeoSieve results and other data available for the Fill WBZ.	Text modified with clarification	Text was added to clarify that the geometric mean hydraulic conductivity values from HydrogeoSieveXL analyses were not used in the groundwater flow model. The geometric mean hydraulic conductivity values were used to select the trench alignment and proportionate trench flow rate to individual grid cells in the uncertainty analysis (Section 4.4.2).
4	Orientation of Hydraulic Gradient	General Comment	N/A	The document does not mention the change in the orientation of the hydraulic gradient in the Fill WBZ subsequent to completion of the LNG Basin lining project in October 2018. Since completion of the project and dependent on season, the gradient rotates between 10 and 20-degrees north of the gradient prior to basin lining. The capture zone depicted in every LNG Basin Trench Design figure reflects the pre-lining orientation of the gradient. The revised version of the design should acknowledge and discuss the extent and orientation of capture zones in the context of the current gradient, not the previous orientation shown in the current document figures.	Text modified as requested	Text was added to discuss the extent and orientation of the capture zones in the context of observed hydraulic gradient following LNG Basin retrofit. A new set of Figures 4-3a through 4-3c was added to show the extent of the capture zones in the context of observed hydraulic gradient following LNG Basin retrofit.

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5	Trench Construction Information	General Comment	N/A	Section 5 discusses the components and construction of the trenches. This section is incomplete and requires additional information. In particular, Section 5.5 should be revised to support the basis of design for the trenches and the methods that will be used during installation, including but not limited to additional details regarding construction quality assurance/quality control (QC) requirements that will be implemented during the system construction to ensure the trenches are built and function in accordance with the design. DEQ's specific comments further clarify the information needs.		Refer to responses on specific comments.
6	Model Modifications	Section 3.1	5	The Draft LNG Basin Trench Design describes changes to the site-wide groundwater model in 2018 to reflect the cessation of pumping from the former Koppers Tank Farm and lining the LNG Basin. DEQ previously reviewed and acknowledged the 2018 model modifications. Section 3.1 identifies additional changes to the model for the LNG Basin Design. DEQ requests that the section discuss these modifications and the associated consequences on model output. DEQ further requests that the section explain the rational for modifying the model at the US Moorings property, and document the basis for selecting a K-value of 40-feet per day for the simulations, including a description of the area over which the K-value was assigned.	Text modified as requested	Text was added to Appendix D, Section 3.1, to explain the rationale for modifying the model at the US Moorings property. A new Figure D-2 was added to show where the hydraulic conductivity modifications were made.
7	Simulation of Fill WBZ Trench	Section 3.3	7	A brief description of the approach to simulating trenches in the Fill WBZ is provided here. DEQ requests the section provide the basis for using a K-value of 40-feet/day in Equation D-1. DEQ's general comment regarding the influence of grid-spacing on model output applies here.	Text modified as requested	Text was added to Appendix D, Section 3.3, to clarify that the K value of 40 feet per day is the Fill Water-Bearing Zone (WBZ) hydraulic conductivity value in the Oregon Department of Environmental Quality (DEQ)-approved groundwater flow model in the area where the trenches were located. Text was also added to discuss the grid spacing on trench simulations.

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8	Modeling Evaluation of Alternative Trench Alignments	Section 4.1	9	The section indicates that trenches in Pacific Terminals (PacTerm) Tank Basin that are either 100-feet or 150-feet long will capture the "entire footprint of the LNG Basin." The section further indicates that adding an additional trench that is either 30-feet or 50-feet in length "...provides little benefit in terms of capture near the LNG Basin." DEQ disagrees with this information for the following reasons: • Consistent with previous discussions, DEQ considers the "footprint" of the LNG Basin to be the full-width of the basin (i.e., from rim-to-rim) normal to the gradient. Under "dry season" simulations, the 100 or 150-foot long trench may not fully capture groundwater over the width of the basin. In addition, under average conditions the capture zone associated with the 100-foot long trench does not encompass monitoring well MW-49F and vicinity (i.e., groundwater exhibiting the highest concentrations of benzene continues to flow towards the river. • Adding either the 30-foot or 50-foot trench benefits groundwater capture by: 1) expanding the capture zone west and further downgradient of MW-49F (i.e., encompasses the monitoring well and more of the plume exhibiting the highest concentrations of contaminants); and 2) expanding the width of the capture zone to the west, lengthening shallow groundwater flowpaths around the capture zone and increasing the travel time of contaminated groundwater to the river.	Text modified as requested	Text was modified to discuss the benefits of adding the 30- or 50-foot trench, as described in the comments.
9	Selection of Trench Alignment	Section 4.2	9	The document indicates that modelling completed to support trench selection indicates a 100-foot long trench is sufficient to hydraulically capture shallow groundwater under the LNG Basin footprint. DEQ's comment to Section 4.1 regarding the 100 or 150-foot long trench applies here.	Text modified as requested	Text was modified to discuss the benefits of adding the 30- or 50-foot trench, as described in the comments.
10	Modelling Evaluation of Selected Trench Alignment	Section 4.3	10	The section provides a general description of the modelling completed to support design. The text should clarify that steady-state simulations produce fully developed capture zones (i.e., cover maximum extent), and the orientation of the capture zone is controlled by the model and does not reflect the direction of the groundwater gradient in the Fill WBZ. Current information indicates that the orientation of the hydraulic gradient in the Fill WBZ generally ranges between approximately 10 and 25-degrees east of north (i.e., rotated 10 to 20-degrees north of those shown in figures).	Text modified as requested	Text was modified to clarify that steady-state simulations represent fully developed capture zones and that the simulated hydraulic gradient does not reflect the direction of observed hydraulic gradient following LNG Basin retrofit.
11	Extreme Weather Conditions	Section 4.4.1	11	An evaluation of trench capture zones during periods of site-specific weather extremes is provided here. DEQ requests clarification on whether the "extreme wet condition" (high) flow estimates represents an instantaneous peak value for groundwater extraction rates, or an average over some period of time.	Text modified with clarification	Text was modified to clarify that the simulated flow rate represents an average over the period with extreme wet or extreme dry conditions.

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12	Non-Uniform Distribution of Hydraulic Conductivity	Section 4.4.2	11	This section describes the approach for simulating the influence of non-uniform K-values along the alignment of each trench. DEQ requests additional information regarding the method used to proportion K-values given the grid-cell spacing is 20-feet and the trenches may be oriented across (not along) cell boundaries. DEQ also requests information on whether the ends of the trenches contribute measurably to flows. A table or figure may be useful to address this comment.	Text modified with clarification	Text was modified to clarify the method for proportionating trench flow rates based on K values. A new set of Figures 4-5a through 4-5c was added to show the model grid cells that represent the trench and the proportionated flow rates.
13	Trench Alignment, Depth, and Width	Section 5.1	13	DEQ's comments on this section of the Draft LNG Basin Trench Design include the following: • According to the 2nd to the last paragraph, the width of the trenches will be based on the bucket width. The bucket width does not appear to be provided in the document. DEQ requests clarification from NW Natural on the minimum design requirement for the width of the trenches to be effective at achieving the targeted capture zones. • The design document does not discuss the QC measures that will be implemented in the field during trench pipe installation to ensure the installed piping meet the design criteria by being set at the bottom of the trench, and that subsequent placement of the fill will to prevent damage to the pipes. The section is incomplete without this information and should be revised accordingly. • A pipe weight is shown in the design details, but the design specifications for the pipe weight should be included in the submittal.	Text modified with clarification	The minimum width of the trench to achieve effective capture is that needed to accommodate the piping diameters specified based on the anticipated flow rates. The minimum width of the excavator bucket is expected to be 2.5 feet, although the specific equipment that may be used is subject to change based on availability and equipment selection to meet field conditions. The text already describes the quality control measures the Contractor will use in excavating the trench ("The Contractor will sound the depth to the bottom of the trench at 10-foot intervals to confirm that the excavation is at least the minimum required depth and within 1.0 foot vertically of the design depth prior to pipe installation") and installing the drain pipe ("The Contractor will measure the elevation of each pipe weight to confirm that the drain pipe is at the correct elevation near the bottom of the trench before placing the granular backfill") in Section 5.2. The dimensions of the pipe weights are given in Appendix E, Drawing C03, Detail 3. The detail was modified to show the thickness of the weight, and a note was added to explain that they are cast concrete.

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14	Construction Method	Section 5.2	13	The first paragraph indicates that the Contractor will sound the bottom of the trench every 10-feet to determine "…the excavation is at least the minimum required depth and within 1.0 foot vertically of the design depth prior to pipe installation." The design should present the depth and elevations of the trench bottom and the bottom of sumps, in the context of the depth/elevation of the bottom of the silt unit. DEQ notes that depending on location, the minimum thickness of the silt unit is approximately 4-feet along the trench alignments. Precautions should be taken to preserve to the maximum extent practicable the thickness of the silt by ensuring the excavation is not taken vertically deeper than the design.	Text modified with clarification	The elevations of the bottoms of the trenches were already provided in tables in Appendix E, Drawing C02. The sumps will be 2 feet deeper than the bottoms of the trenches, so the elevation at the bottom of the sump at Station 0+57.94 in the primary trench will be 3.25 feet, and the elevation at the bottom of the sump at Station 0+27.71 in the secondary trench will be -0.8 feet. The additional details were added to the tables in the drawing. The depth of each trench was selected specifically to avoid penetrating the silt layer while also allowing the drain to lower the water table to the base of the Fill WBZ without dewatering the trench near the drain pipe, as well as providing a slope to promote the removal of dense nonaqueous phase liquid (DNAPL) if encountered. This was explained in Section 5.1.
15	Surface Completion/Primary Trench	Section 5.4.2.1	16	If the material source is known please include the source information in the report. At a minimum, grain size and material density should be measured for the inert source material - What additional chemical or physical testing planned for the overlying surface material at the top of each trench?	Text modified with clarification	The grain size is already provided in Table 5-2. The identity of the vendor and bulk density for the granular backfill of the material was added to Section 5.4.1. Verification of grain size and chemical concentrations will be requested from the vendor. We are in the process of identifying a vendor and selecting fill materials, and the vendor will provide full characterization once the selection is made.
16	Connection to Groundwater Treatment System/Pumps, Controllers, and Piping: Piping	Section 5.5.1	17	Comments on the section are provided below according to topic: DEQ's comments on piping include the following: • DEQ requests verification that; 1) the strength of the thin-walled, SDR pipe is sufficient for the overburden pressures within the trench and that deformation of the collection pipe will not occur during placement of the fill; and 2) all piping is chemically resistant with respect to MGP NAPL. • All conveyance piping should be pressure tested to assess for leaks following installation and prior to the initiation of system start-up and testing. Testing requirements and acceptance criteria should be identified in the revised design document. • DEQ recommends that tracer wire be installed above piping. If the design includes tracer wire, DEQ requests it be shown on the plan details.	Text modified with clarification	The specified pipe is of standard thickness and is not "thin walled." The minimum wall thickness of this pipe is 0.390 inch and provides sufficient stiffness for this application with the pipe/backfill system. The text in Section 5.3 was revised to document the basis for selecting the DR17 pipe for the drain pipe. The text in Section 5.5.1 was revised to describe testing the conveyance piping and the placement of a tracer wire above buried conveyance piping. The route of conveyance piping is shown in Appendix E, Drawing C05.

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17	Connection to Groundwater Treatment System/Pumps, Controllers, and Piping: Non-Aqueous Phase Liquid (NAPL)	Section 5.5.1	17	Comments regarding NAPL are provided below. • The potential presence of NAPL in the trench warrants including explosion proof motors in the pumps specified in the design. The pump specifications should be provided in the revised version of the design document. • At a minimum, LEL readings should be collected from the vault and cleanouts at the trench and any enclosures along the discharge conveyance lines to ensure volatile vapors aren't accumulation in the trench or sump area. These measurements should be collected before and during system start-up operations, as well as during routine operations. The LNG Basin Trench Design should be revised accordingly.	Text modified with clarification	An explosion-proof pump is specified for the 100-foot primary trench because it is located in the secondary containment for fuel aboveground storage tanks rather than because of the potential presence of nonaqueous phase liquid (NAPL). No NAPL was observed in the fill borings along the trench alignments. An explosion-proof pump is not warranted for the 50-foot secondary trench because the motor will be submerged, and in the absence of air, the potential for explosion is negligible. Pump specifications are provided in the final document.
18	Connection to Groundwater Treatment System/Pumps, Controllers, and Piping: Fail-Safes	Section 5.5.1	17	The design document does not include information regarding the built-in fail-safes integrated into the system operational controls. For example, shut-down of the Gasco Pre-Treatment Facility should automatically trigger shut-down of the trench pumps.	Text modified as requested	Text was added to the end of Section 5.5.1.
19	Connection to Groundwater Treatment System/Pumps, Controllers, and Piping: NPDES Permit Modifications	Section 5.5.1	17	The revised design should describe the groundwater treatment plant NPDES permit requirements, including NPDES permit number and any specific trench system upgrades that are needed to comply with the NPDES permit, or any changes to the permit necessary for treatment of trench discharge. If the NPDES permit is updated, DEQ requests that a copy of the authorized updated permit be included as an appendix to the revised design document.	Text modified as requested	The final design was revised to describe the increased capacity needed to manage the additional water recovered from the Fill WBZ trenches and cite the National Pollutant Discharge Elimination System (NPDES) permit number.
20	Connection to Groundwater Treatment System/Pumps, Controllers, and Piping: System Start-up and Testing	Section 5.5.1	17	The revised LNG Basin Trench Design should include a plan for the initial start-up, development, and testing of the trenches, and for system operations during the initial weeks and months subsequent to starting the system. The plan should include a site visit schedule, identify field measurements, and provide copies of field forms for recording the details of system operations during site visits.	Text modified as requested	A new subsection (Section 5.5.3) was added to describe start-up testing for the expanded pretreatment system, and text was added to Section 6.1 to describe the testing of the trench piping system.
21	Connection to Groundwater Treatment System/Pumps, Controllers, and Piping: Excavated Material and Waste Management	Section 5.5.1	17	The revised design should include a section that discusses the handling and management of excavated soil and other wastes during and project implementation and subsequent to completion.	Text modified as requested	The final design (Section 5.2) notes that excavated material and other solid waste will be managed in accordance with the *Contaminated Materials Management Plan* (Anchor QEA 2019f).

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22	Monitoring	Section 6.2	19	DEQ requests that additional piezometers be incorporated into the removal action monitoring plan to evaluate the hydraulic influence of the trenches at the following locations: • Approximately half-way between the two trenches within the Pacterm Basin to confirm the overlap of the two trench capture zones; and • Near the northwestern edge of the LNG Basin approximately half-way between monitoring wells MW-06-32 and MW-43F to assess the western extent of the capture zone Figure 6-1 should be revised accordingly.	Text modified as requested	Two monitoring wells were added to Figure 6-1 at the locations described by DEQ. The relevant wording in Section 6.2 was changed from "two" to "four."
23	Schedule	Section 7	20	DEQ requests that the schedule shown by Figure 7-1 be revised to include a line item for start-up activities. Please also identify the permits that will be required and estimated submittal dates and associated agency review times. The schedule includes a line item for "Pretreatment System Expansion." The schedule appears to be the only reference to the expansion in the draft design document. DEQ requests that the revised LNG Basin Trench Design include a section describing modifications to the Gasco Pretreatment Facility associated with the trench removal action.	Text modified as requested	A line item for start-up activities was added to Figure 7-1, and the line item for permitting was removed. A new subsection (Section 5.5.2) was added to explain that the capacity of the pretreatment system will be expanded without changing the operations. DEQ reviewed the change and determined that the NPDES permit would not require modification, and the correspondence is included in a new appendix (Appendix G).
24	Appendix D	N/A	N/A	DEQ's comments on the appendix include the following: • DEQ's general comments on the orientation of the hydraulic gradient applies to figures D-2a through D-2c and D-3a through D-3c in the appendix. • The assumed recharge rate of 50% of precipitation for unvegetated pervious surfaces (with no surface water runoff) appears low, and suggests 50% of rainfall is evaporating from areas of with surfaces of bare soil and/or gravel. A value of 50% may underestimate likely recharge. DEQ expects to revisit these assumptions after sufficient performance monitoring data has been collected.	Text modified with clarification	Text was added to clarify that the hydraulic gradients shown in these figures reflect the simulated hydraulic gradients, not the observed hydraulic gradients after LNG Basin retrofit. We acknowledge the need to revisit the recharge rate assumption based on trench performance monitoring data.
25	Appendix E	N/A	N/A	The appendix is incomplete without a drawing clearly showing piping runs and connections between the individual trenches and/or to the Gasco Pre-Treatment Facility, including the locations of, and the details for tie-ins.	Text modified as requested	A new drawing (Drawing C05) was added to show the conveyance piping and related details.
26	Appendix E	Figure G-03	N/A	The figure shows existing site conditions within the removal action project area. DEQ requests that site features (e.g., PacTerm Marine Fuel Storage Tanks, PacTerm Tank Basin, LNG Tank Basin, PacTerm Truck Loading Rack) be added to the figure for reference.	Text modified as requested	These additional features were labeled in Drawing G03.

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27	Appendix E	Drawing C-03, Details 1 and 2	N/A	Comments regarding the figure include the following: • Detail 1 – The ground surface should be mounded to allow for potential surface subsidence and to encourage rainfall runoff from the trench. A minimum depth for the uppermost backfill material should specified on the drawing. DEQ recommends a minimum of 5-feet for the surface material. The material compaction requirements should be included in Section 5.4.2 of the revised document. • Detail 1 or 2 – Consistent with Section 5.2, DEQ requests that the detail show or indicate that pipe weights will be attached at 10-foot intervals.	Text modified with clarification	Detail 1: The surface completion for the 100-foot primary trench is granular backfill (grain size distribution is provided in Table 5-2 in Section 5.4.2.1) and is not intended to exclude rainfall infiltration. The detail has been modified to show mounding of fill. No compaction is necessary or proposed for the granular fill. Surface completion fill will be placed in the top 2 feet of the trench as was already noted in Section 5.4.2.1; this dimension has been added to the drawing. Detail 2: Notes will be added to the detail, including a note that pipe weights will be spaced 10 feet apart along the length of the drain pipe.
28	Appendix E	Drawing C-03, Detail 3	N/A	DEQ has a number of comments regarding this detail. • A perforated 18-inch diameter sump is shown. The potential for NAPL to occur along the trench alignments is recognized. The sump should use blank pipe to retain any NAPL accumulation for removal. • The pipe labelled "6" DR17 HDPE LONG-SWEEP (6' RADIUS) ELBOW AND 6" HDPE PIPE 18" should also be identified as a "cleanout riser." • DEQ requests that a detail for cleanout riser-pipe surface completions be added to the drawing.	Text modified with clarification	The sump pipe is slotted to allow the collection of DNAPL from the granular fill surrounding the sump. Per discussion with DEQ, the sump design was kept slotted.The cleanout riser is now identified as such in Detail 4 of Drawing C03. An additional detail was added to Drawing C03 to show surface completion for the cleanout risers.
29	Appendix F	N/A	N/A	DEQ requests that the cut sheets for pumps, transducers, motor controllers, and other equipment be provided in the revised version of the design document. Also provide calculations for required head and estimated head loss for the water discharged along each conveyance line.		Technical data for conveyance piping and ancillary equipment were added to a new appendix (Appendix H). Head loss calculations for the conveyance piping are also provided in this appendix.

Notes:
DEQ: Oregon Department of Environmental Quality
DNAPL: dense nonaqueous phase liquid
LNG: liquefied natural gas
N/A: not applicable
NAPL: nonaqueous phase liquid
NPDES: National Pollutant Discharge Elimination System
WBZ: water-bearing zone